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SM2A-07-BP13

# NASA
# SUPPORT MANUAL

# APOLLO SPACECRAFT

# DESCRIPTION

# BOILERPLATE 13

10

(TITLE UNCLASSIFIED)

CONTRACT NAS9-150
EXHIBIT I; PARAGRAPH 10.3

THIS MANUAL REPLACES SM2A-07-BP13 DATED 14 FEBRUARY 1964

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# INTRODUCTION

This manual pertains to the mission, and provides physical and operational descriptions of boilerplate 13, part No. B14-000002-171, manufactured by Space and Information Systems Division of North American Aviation, Inc., Downey, California. Supporting documentation and ground support equipment is described in general terms. Functional schematics and block diagrams are also included in this manual. The applicability of this manual is listed in the Index of Apollo Support Manuals and Procedures, SM1A-1.

# SECTION I

# MISSION AND OBJECTIVES

## 1-1. PURPOSE.

1-2. This section describes the mission and objectives of boilerplate 13 (figure 1-1). A mission profile is shown in figure 1-2.

## 1-3. BOILERPLATE 13 MISSION.

1-4. The Apollo-Saturn compatibility tests have the initial objectives of developing and qualifying the spacecraft and systems to be used for manned earth-orbital flight. The unmanned boilerplate 13 configuration is the first of these launch vehicle and spacecraft compatibility tests. This test will also serve to demonstrate certain environmental and systems compatibilities. Boilerplates are research and development vehicles which simulate production spacecraft in size, shape and structural soundness. Boilerplate 13 is equipped with instrumentation to record mission parameter data for engineering review and evaluation. The data gained from testing of boilerplate configurations will be used in determining production spacecraft flight parameters.

## 1-5. APOLLO FIRST ORDER TEST OBJECTIVES.

1-6. The following are the primary test objectives of the boilerplate 13 flight test:

a. Demonstrate the physical compatibility of the launch vehicle and spacecraft under preflight and flight conditions.

b. Determine the launch and exit environmental parameters for verification of design criteria.

## 1-7. APOLLO SECOND ORDER TEST OBJECTIVES.

1-8. The following are the secondary test objectives of the boilerplate 13 flight test:

a. Demonstrate the structural integrity of the launch escape system under flight loading conditions.

b. Demonstrate satisfactory launch escape tower jettison.

c. Demonstrate compatibility of the R&D communications and instrumentation systems with launch vehicle systems.

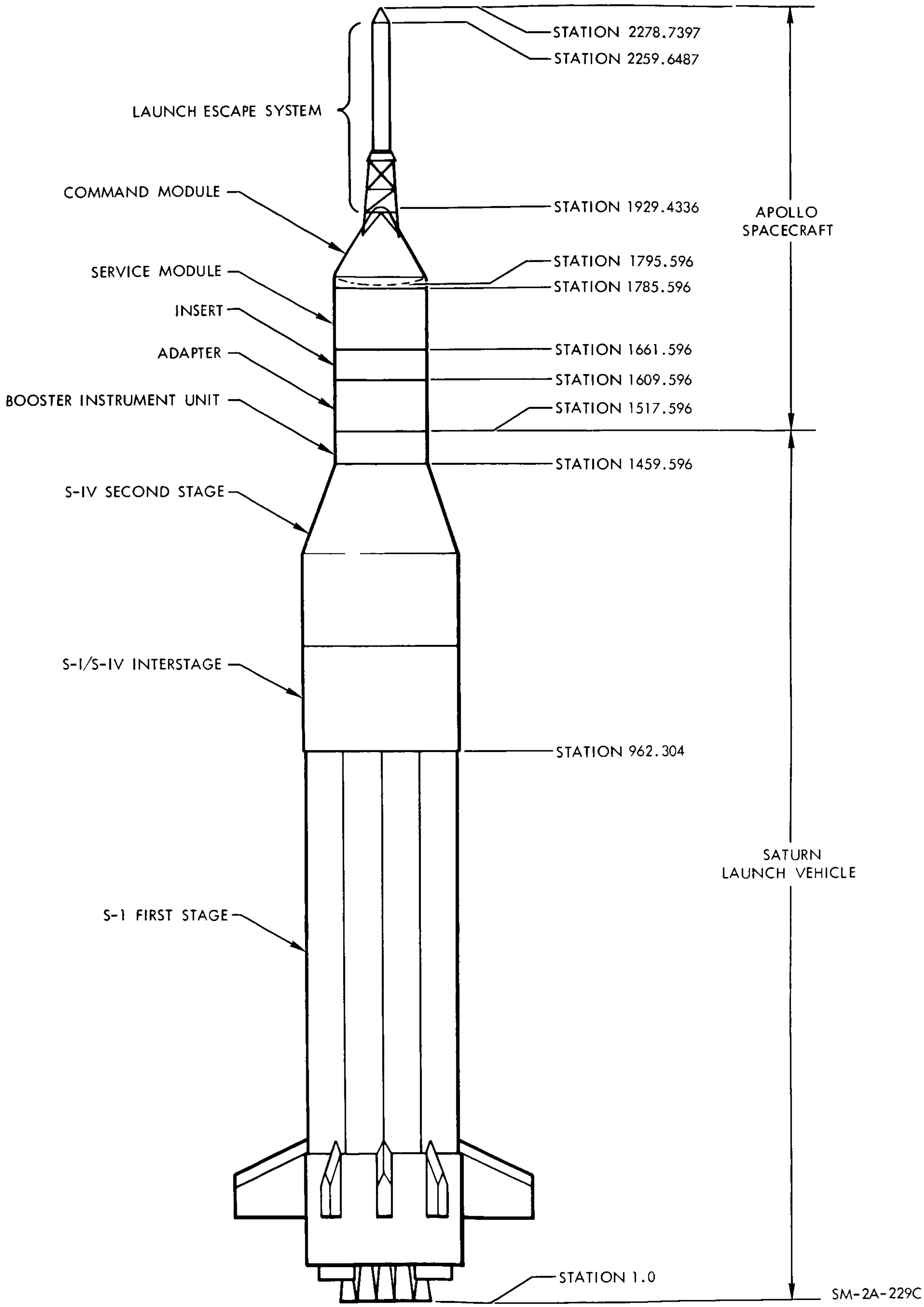
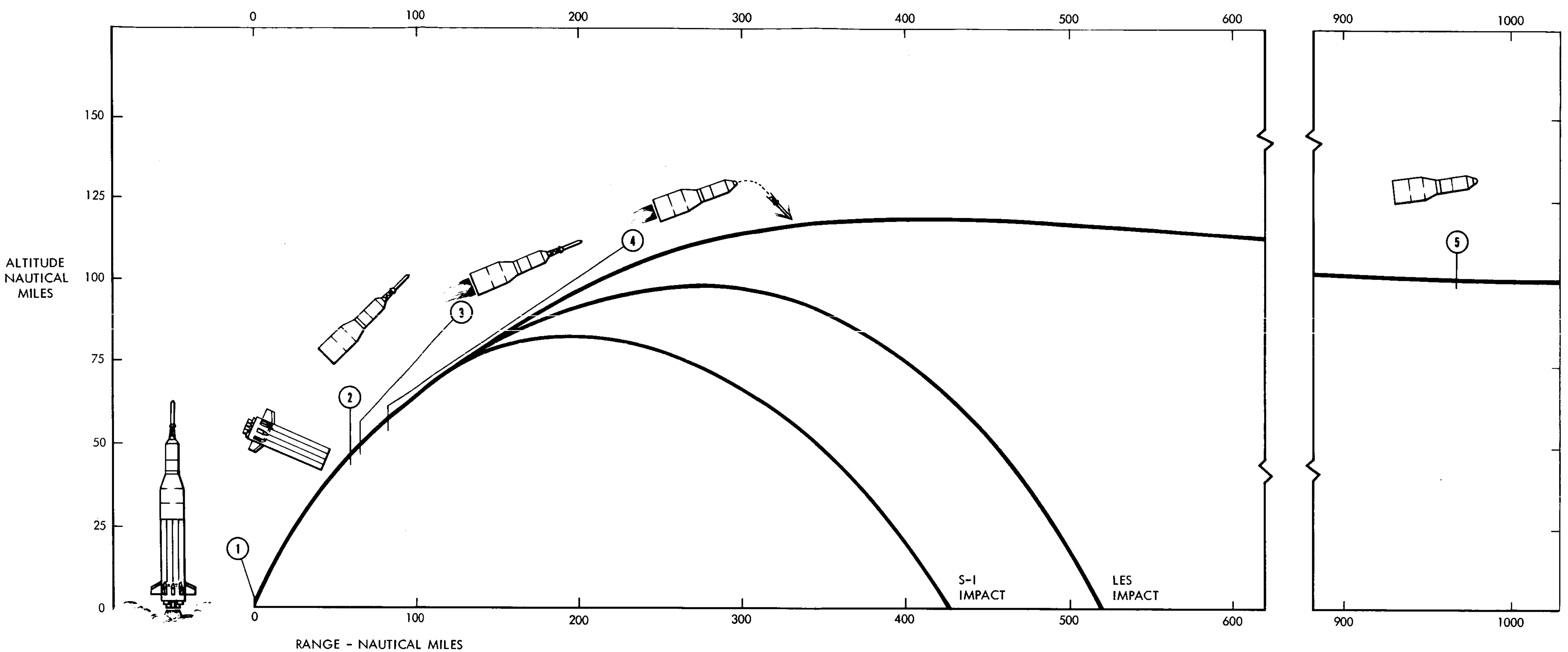



Figure 1-1. Booster Compatibility Space Vehicle




| SEQUENCE OF MAJOR EVENTS | | |
|---|---|---|
| 1 LAUNCH (LIFT-OFF): | 3 S-IV IGNITION | 5 S-IV BURNOUT AND ORBIT INJECTION |
| 2 S-I BURNOUT AND SEPARATION | 4 LES JETTISON | |

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Figure 1-2. Flight Sequence and Trajectory

# SECTION II

# PHYSICAL DESCRIPTION

## 2-1. PURPOSE.

2-2. This section contains a physical description of the launch escape system, command module, service module, insert, and adapter. The boilerplate 13 spacecraft, mounted on a Saturn I launch vehicle, comprises the complete test vehicle. (See figure 1-1.)

## 2-3. LAUNCH ESCAPE ASSEMBLY.

2-4. Structural relationships and physical location of the components of the assembly are shown in figure 2-1. Pertinent physical characteristics are contained in table 2-1.

Table 2-1. Launch Escape Assembly Physical Characteristics

| | |
|---|---|
| Overall Dimensions: | |
| Length | 33 feet |
| Weight | 6600 pounds (approx) |
| Tower Structure: | |
| Length | 118 inches |
| Width (top of tower) | 36 inches |
| Width (bottom of tower) | 50.6 inches |
| Weight | 533 pounds (approx) |
| Structural Skirt: | |
| Length | 18.25 inches |
| Diameter | 48.8 inches |
| Weight | 227 pounds |
| Launch Escape Motor: | |
| Length | 185.3 inches |
| Diameter at nozzle exit | 28 inches |
| Diameter of motor structure | 26 inches |
| Weight | 4809 pounds (approx) |

Table 2-1. Launch Escape Assembly Physical Characteristics (Cont)

| | |
|---|---|
| **Tower Jettison Motor:** | |
| Length | 55.6 inches |
| Diameter at nozzle exit | 28 inches |
| Diameter of motor structure | 26 inches |
| Weight | 529 pounds (approx) |
| **Pitch Control Motor Structure:** | |
| Length (includes ballast and motor structure) | 18.62 inches |
| Diameter | 26 inches |
| Weight | 158 pounds (approx) |
| **Pitch Control Motor:** | |
| Length | 22 inches |
| Diameter of body | 8.79 inches |
| Diameter of flange | 10.51 inches |
| Weight | 47 pounds (approx) |
| **Ballast:** | |
| Diameter of lead discs | 20.5 inches |
| Thickness | 1.13 inches |
| Weight | 189 pounds (approx) |
| **Ballast Enclosure:** | |
| Length | 29 inches |
| Diameter (forward end) | 13.1 inches |
| Diameter (aft end) | 26 inches |
| Weight | 73 pounds (approx) |
| **Nose Cone (Q-Ball):** | |
| Length | 19.09 inches |
| Diameter (forward end) | 2 inches |
| Diameter (aft end) | 13.03 inches |
| Weight | 22 pounds (approx) |

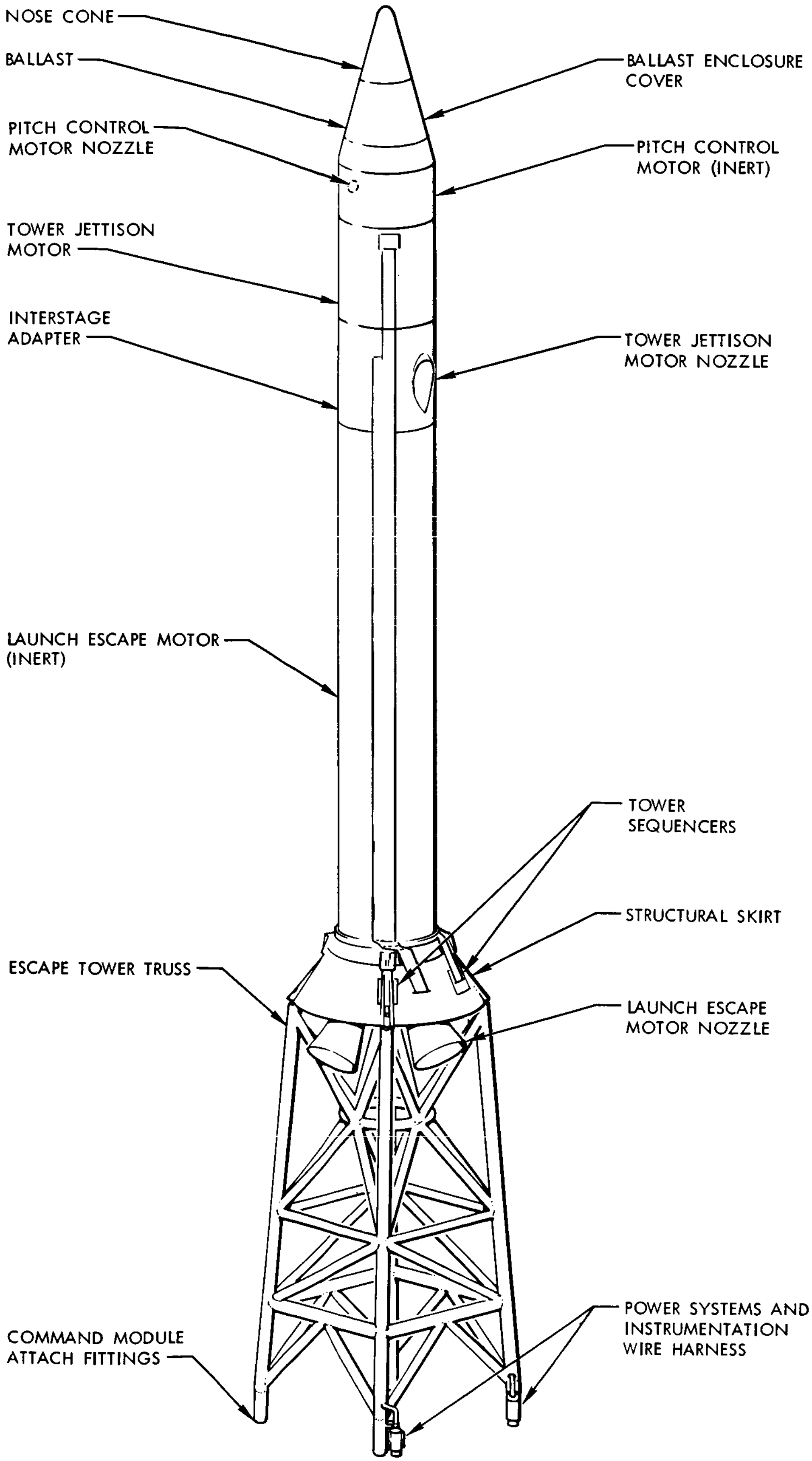



Figure 2-1. Launch Escape Assembly

2-5. STRUCTURE. The truss-type tower structure is the base of the launch escape assembly. It is an open frame of welded titanium tubing covered with silica-filled Buna-N rubber for thermal insulation. Each of the four legs is attached to the command module by an explosive bolt. (See figure 2-2.) Attachments at the top of each tower leg facilitate tower alignment. (See figure 2-3.) The structural skirt is attached between the top of the tower structure and the base of the launch escape motor. The housing of the launch escape motor forms the structure between the structural skirt and the interstage structure. The interstage structure (figure 2-4), is a welded-cylindrical structure which houses the tower jettison motor exhaust nozzles and various electrical components. Two access doors facilitate installation and removal of the components. The ballast housing and the nose cone are of welded Inconel sheet construction, and are bolted together to form a single conical structure to house the sheet lead ballast. (See figure 2-5.) The Q-Ball replaces the nose cone when installed. (See figure 4-3.)

2-6. LAUNCH ESCAPE SYSTEM MOTORS. The three launch escape system motors are stacked above the tower structure. Boilerplate 13 launch escape motor and pitch control motor are inert. The tower jettison motor utilizes a star-grain solid propellant of a polysulfide ammonium perchlorate formulation. The jettison motor has two fixed nozzles. Passive thrust vector control is used to obtain proper jettison trajectories.

2-7. LAUNCH ESCAPE SYSTEM ELECTRICAL AND ELECTRONIC COMPONENTS. The electrical and electronic components in the launch escape system consist of launch escape sequencers (contained in the command module and on the structural skirt), hot wire initiators, and associated wiring harnesses and attachements. Redundant wiring harnesses are bonded to the exterior of the launch escape motor, and associated redundant harnesses are integral to the tower structure. Each tower structure harness has a breakaway plug that allows the harness to detach itself from the command module when the launch escape tower is jettisoned. The wiring harnesses provide the means of connecting the rocket motor and separation circuits with the sequence controllers, and the instrumentation components with the communications equipment.

2-8. SEQUENCERS. Three sequencers are provided to program the sequence of events during the mission. Two tower sequencers located on the structural skirt are identical in size and shape. Each tower sequencer is approximately 2.5 inches in width, 8.25 inches deep, and 3.75 inches high. See figure 2-3 for location. A mission sequencer is installed in the command module. The mission sequencer is a single-enclosed assembly approximately 15 inches wide, 8.25 inches deep, and 7 inches high. See figure 2-7.

2-9. HOT WIRE INITIATORS. The two hot wire initiators (figure 2-4) for the tower jettison motor are threaded plug devices. Both initiators contain the electrical circuitry and explosive necessary to detonate the motor igniters. The initiator body is 1 inch long with a 0.75-inch flange, 0.45 inch from the threaded

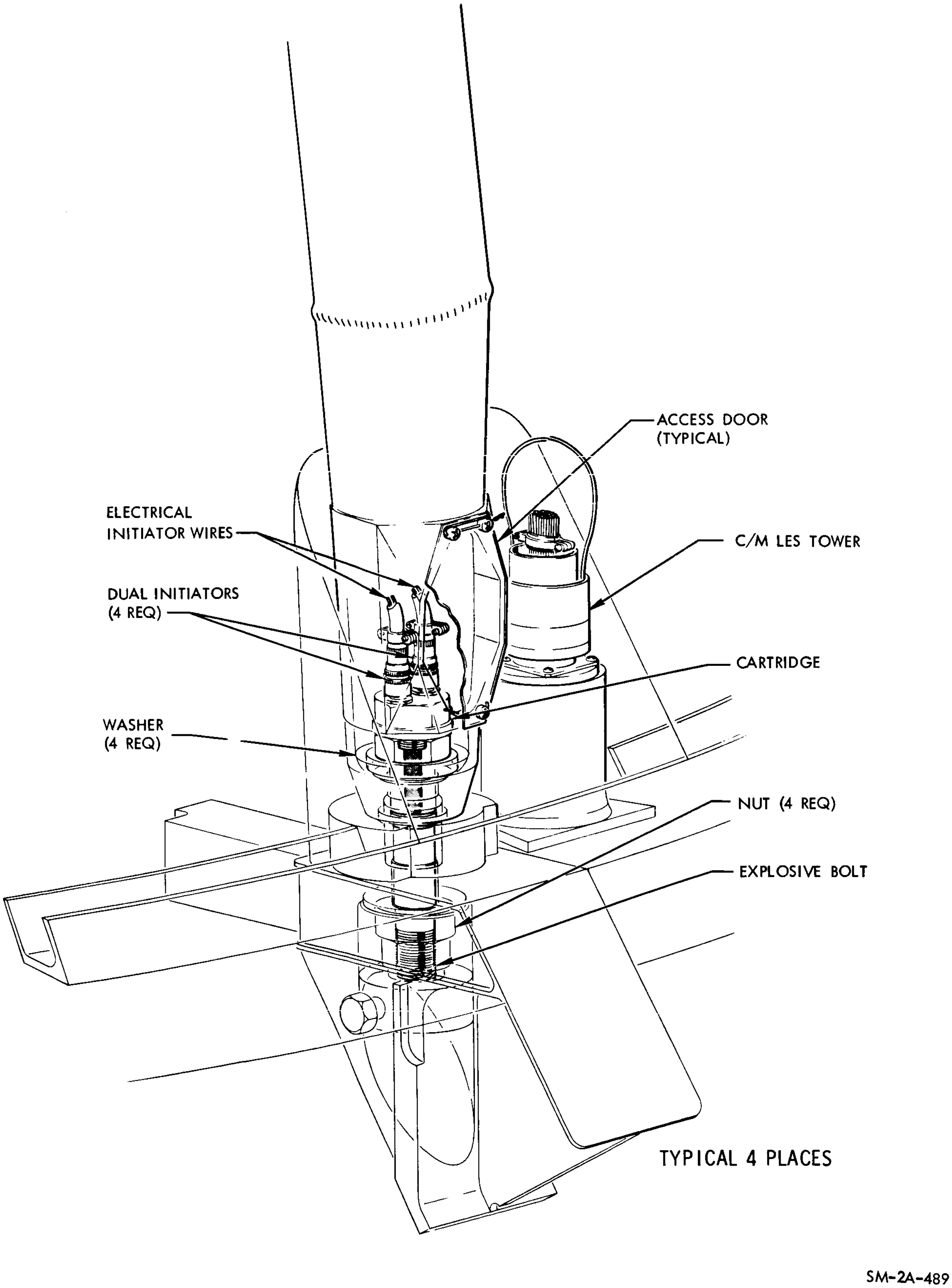
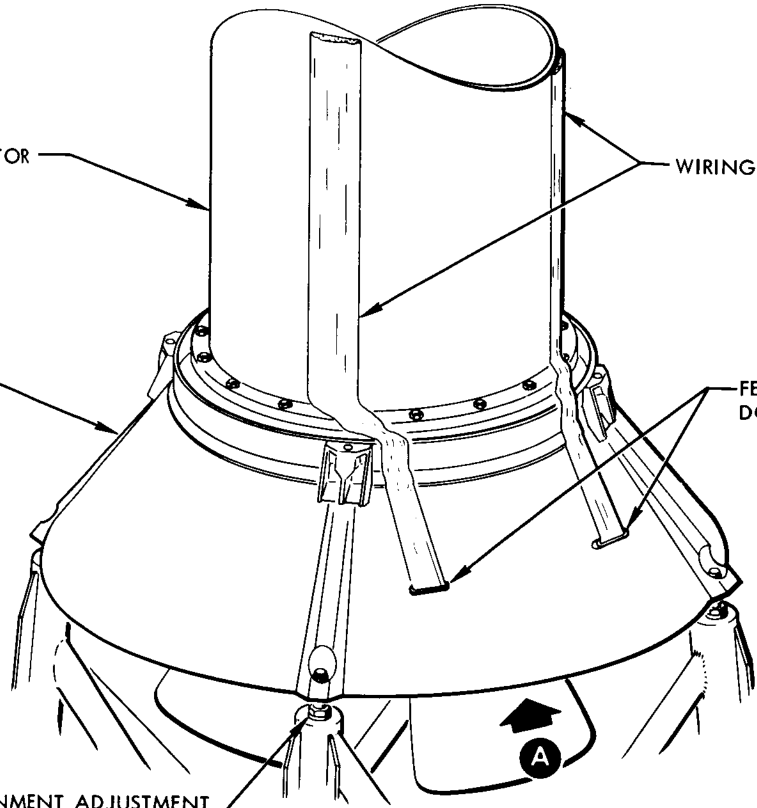
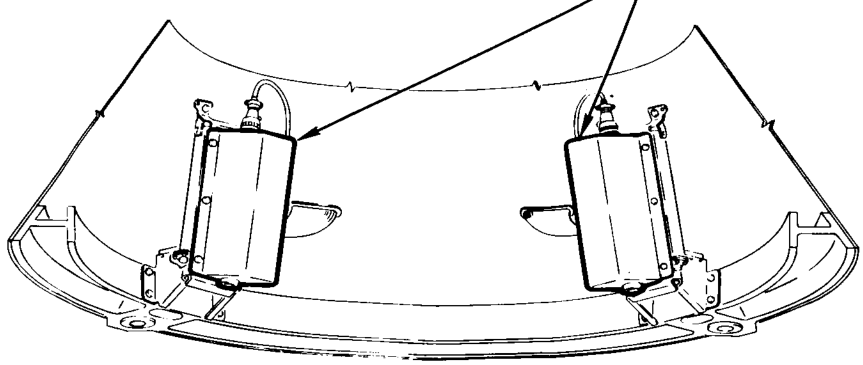



Figure 2-2. Escape Tower Explosive Bolt




VIEW A

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Figure 2-3. Launch Escape Motor and Structural Skirt Area

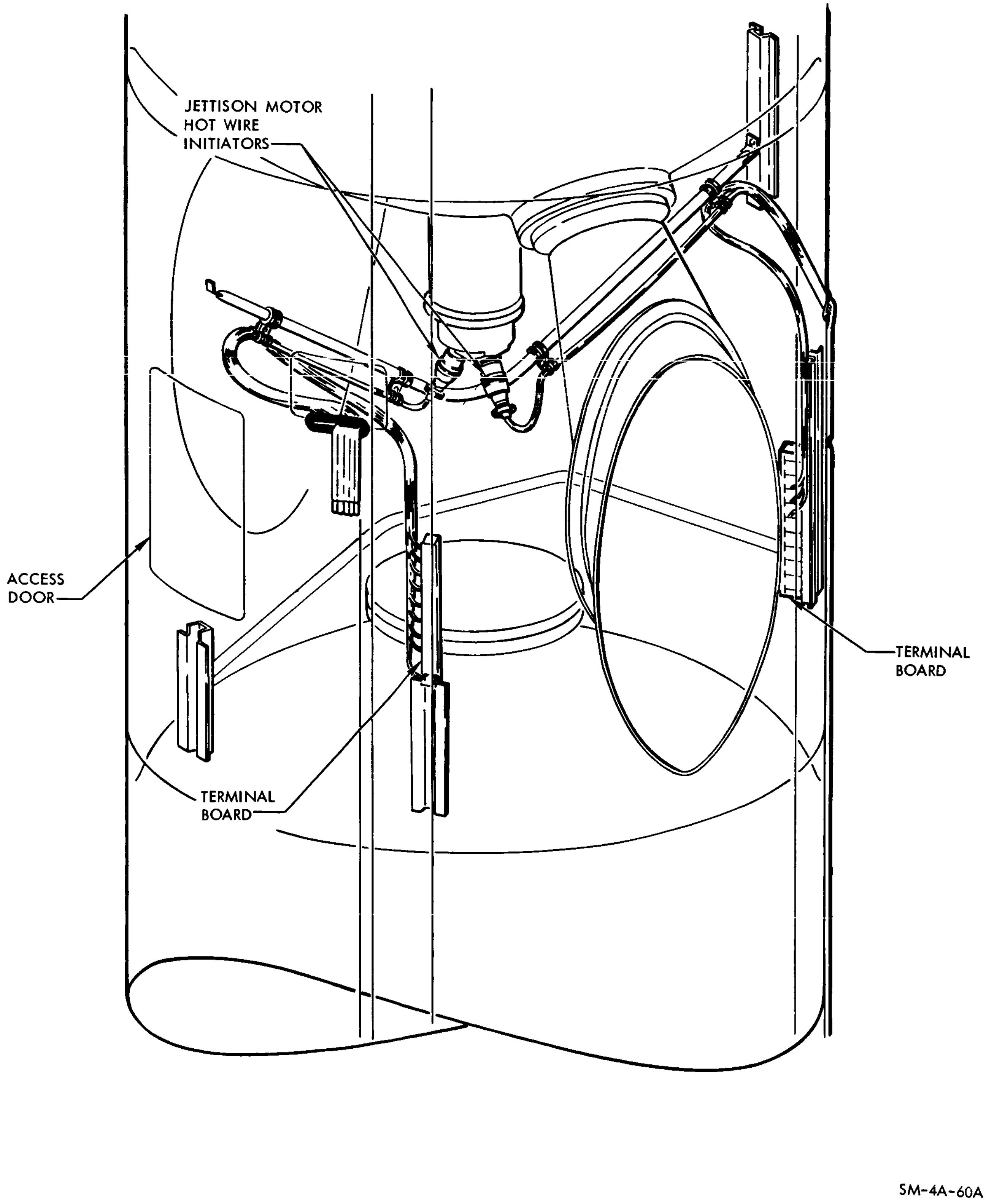



Figure 2-4. LES Interstage Adapter Area Components

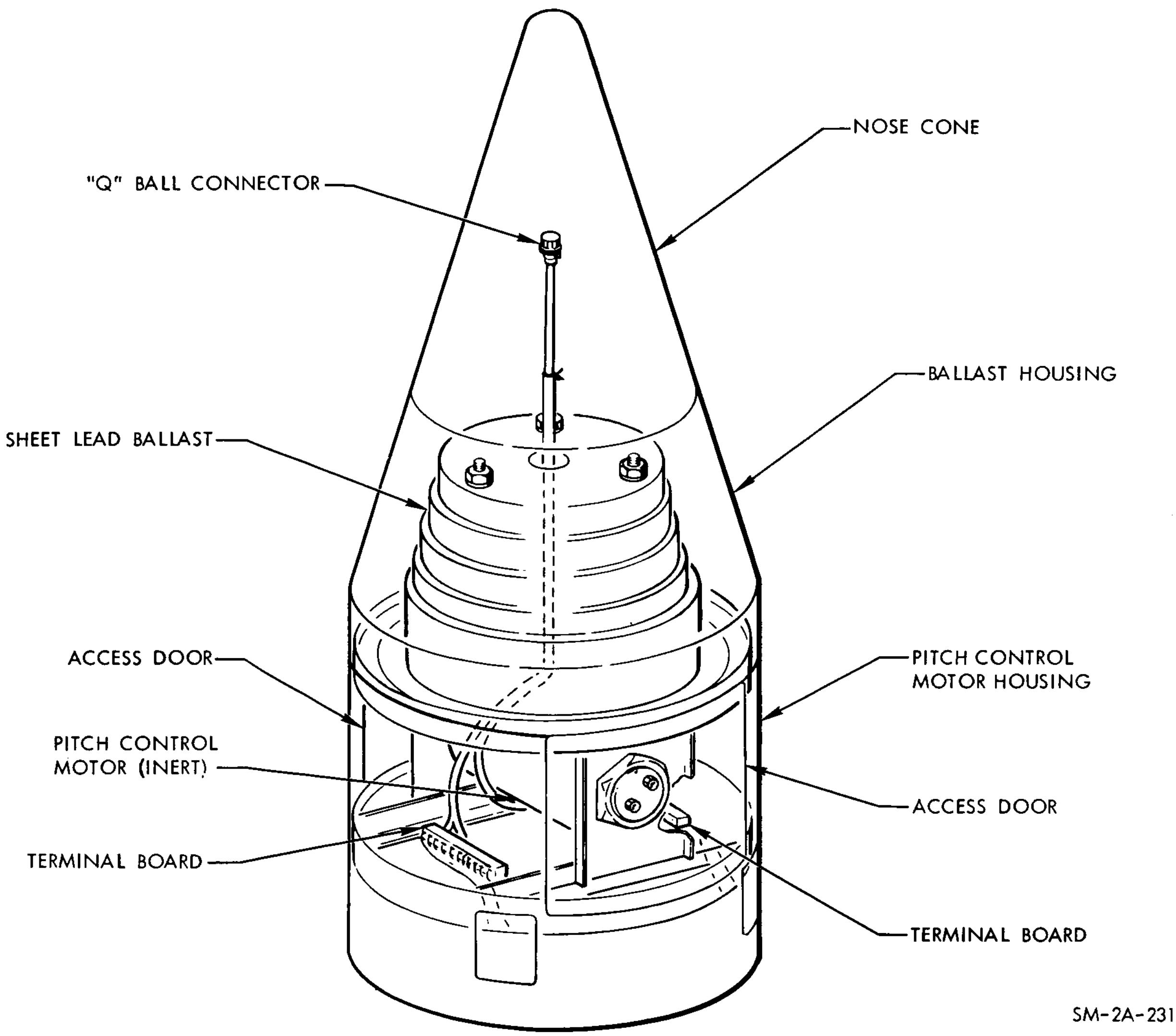



Figure 2-5. Nose Cone and Pitch Control Motor Area

end. Threads are located on one end and an electrical connector at the other end. The electrical connector contains four pins to supply power to two independent bridge-wire circuits.

2-10. LAUNCH ESCAPE TOWER UMBILICAL CONNECTORS. Two electrical umbilical connectors join the electrical systems of the launch escape assembly and the command module. These connectors are located on the plane-of-separation adjacent to the escape tower leg wells of the forward heat shield of the command module. (See figure 2-2.) The receptacle portion of the connector is attached to the command module structure. The plug is attached to the nearest tower leg by a lanyard. When the escape tower separates from the command module, the lanyard pulls the plug from the receptacle. The plugs are part of the launch escape tower wiring installation and separate with the tower. The receptacles are part of the command module wiring installation and remain with the command module.

2-11. COMMAND MODULE. (See figures 2-6 and 2-7.)

2-12. The boilerplate command module simulates the production command module in external size and shape. Physical characteristics for the command module are listed in table 2-2. The reference axes are shown in figure 2-8.

Table 2-2. Command Module Physical Characteristics

| | |
|---|---|
| Shape | Conical |
| Height | 134 inches |
| Diameter | 154 inches |
| Weight | 9262 pounds (approx) |

2-13. STRUCTURE. The command module structure is conical with a convex base and a rounded apex. The sides are semimonocoque aluminum structures and terminate in the forward and aft heat shields. The command module is covered with a cork material to protect the aluminum structure against aerodynamic heating. The crew compartment area is insulated from the side walls with a quilted-fiberglass material. The insulation helps to provide and maintain a constant temperature of not greater than 150 degrees Fahrenheit and to reduce the heat flow inside the compartment. A main hatch in the side of the primary structure permits access to the interior. Shelves and brackets along the inner wall afford mounting provisions for equipment. Compartmentation is described in table 2-3.

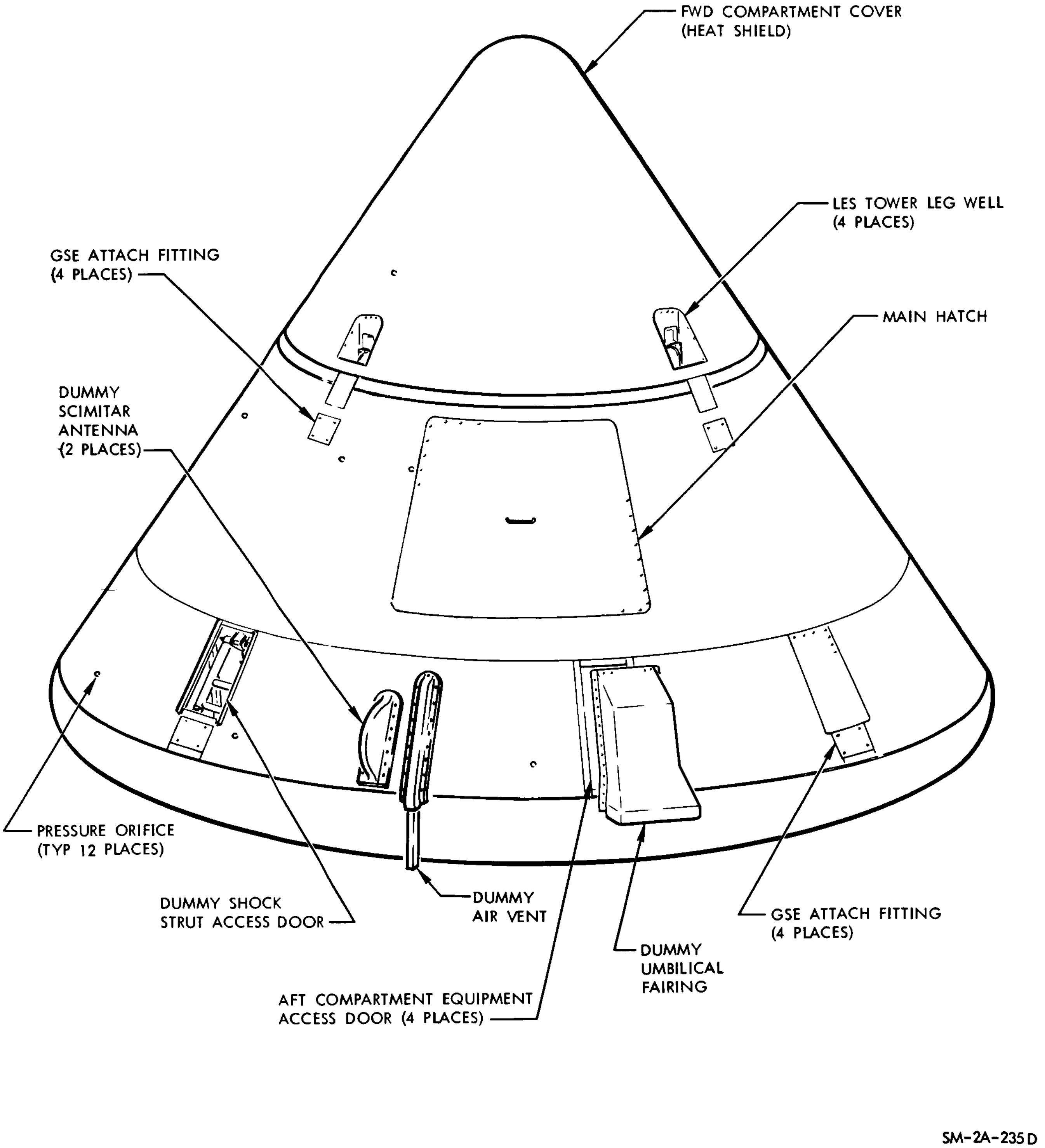



Figure 2-6. Command Module

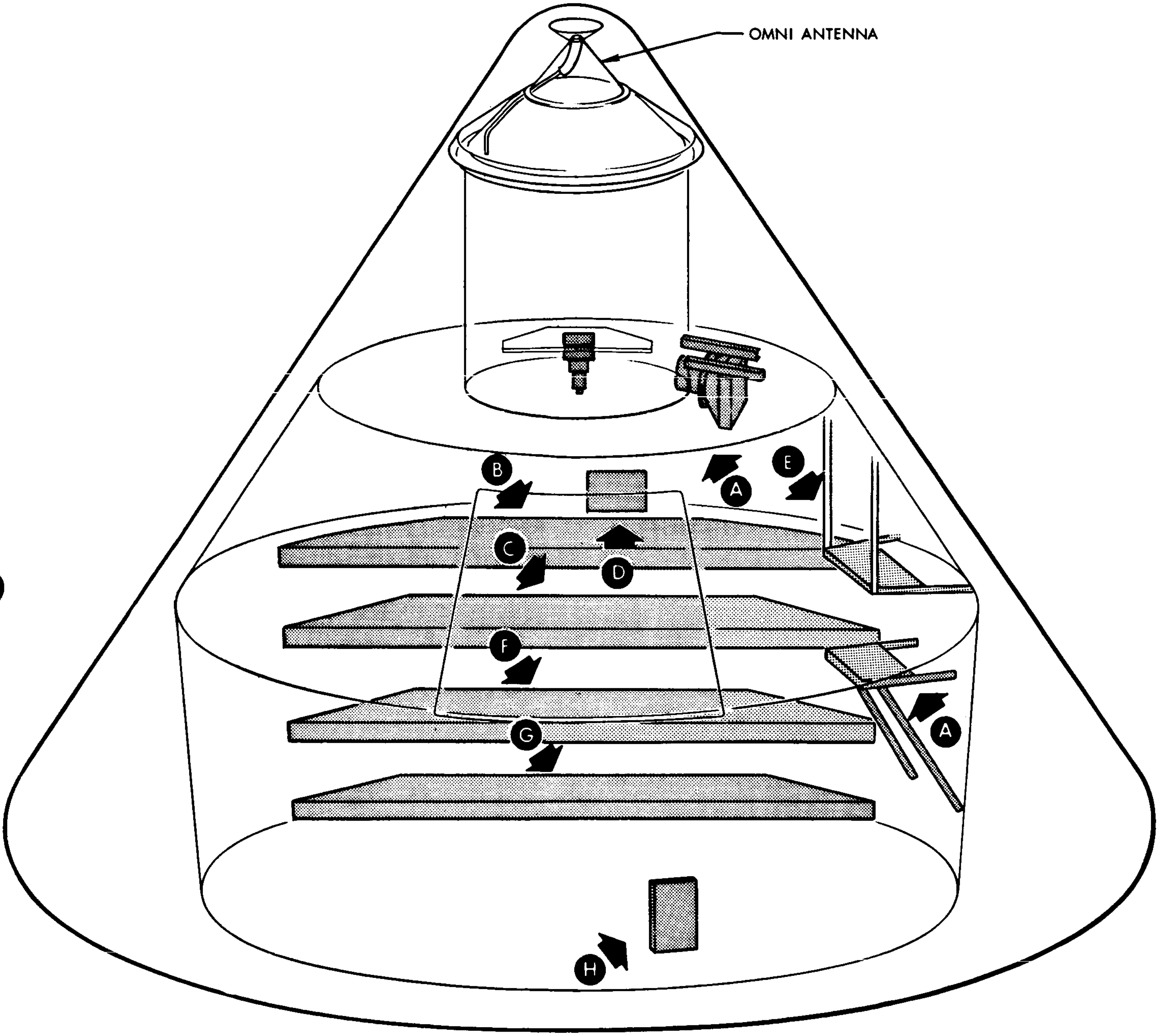



Figure 2-7. Command Module Interior (Sheet 1 of 5)

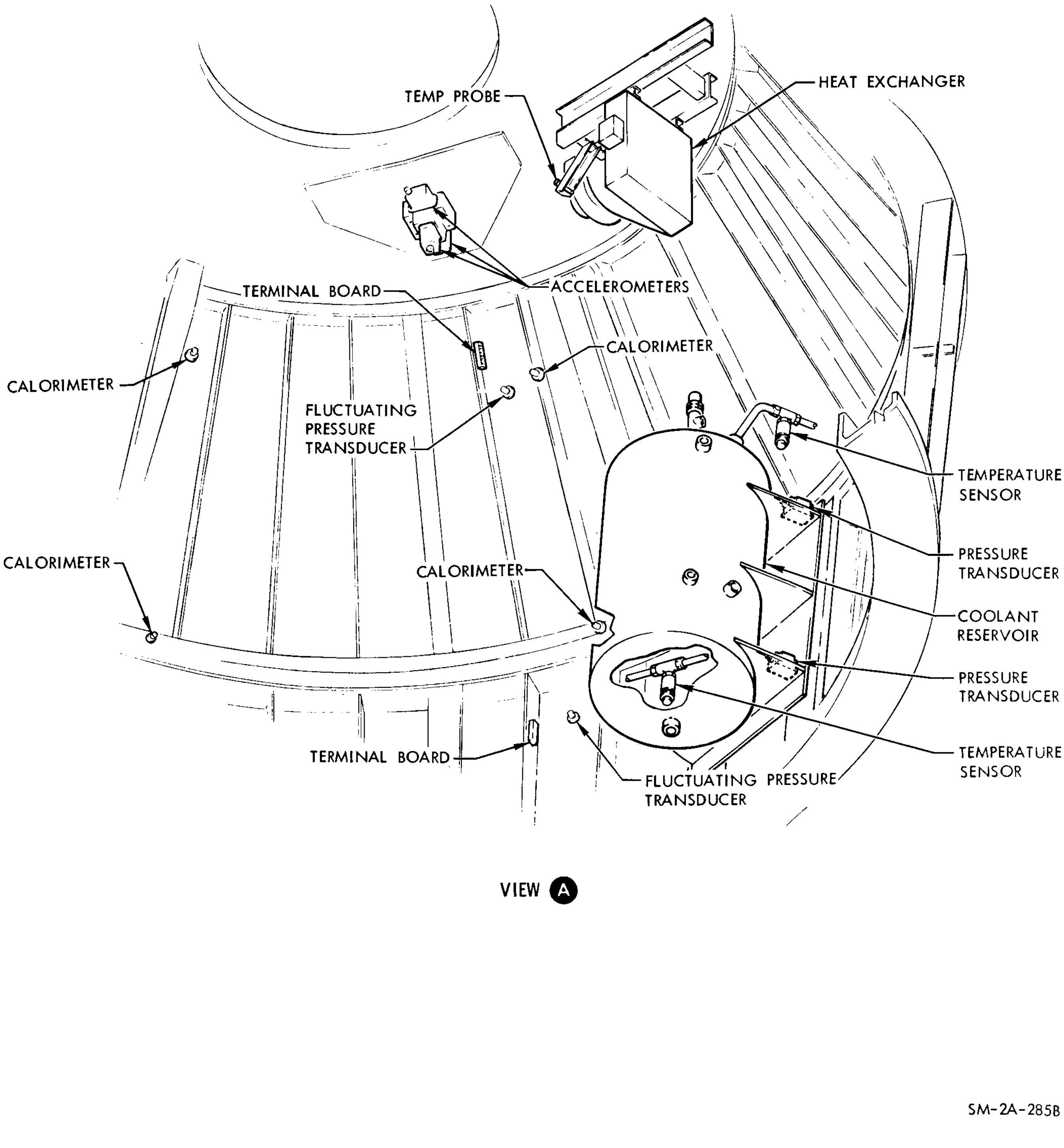



Figure 2-7. Command Module Interior (Sheet 2 of 5)

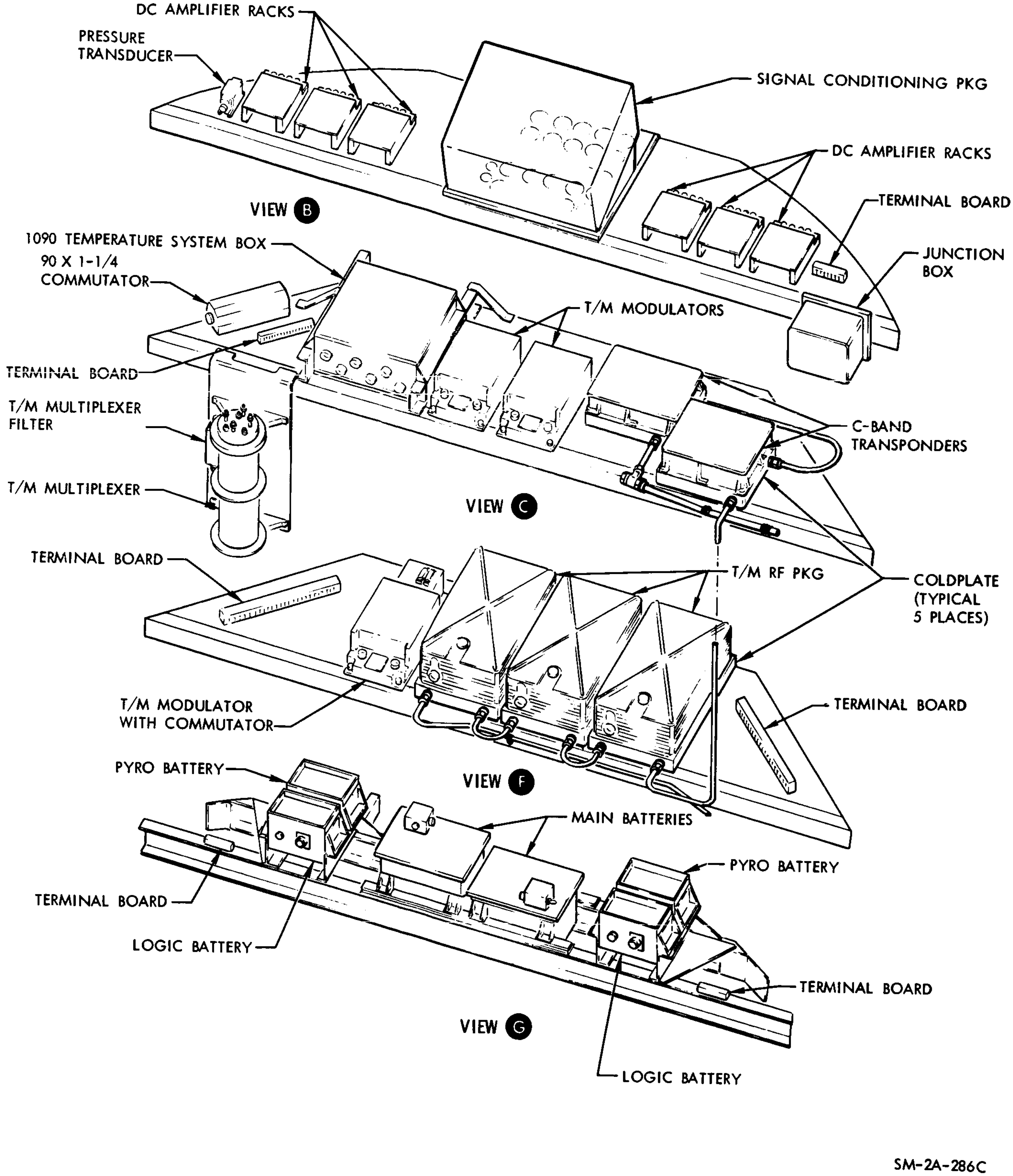



Figure 2-7. Command Module Interior (Sheet 3 of 5)

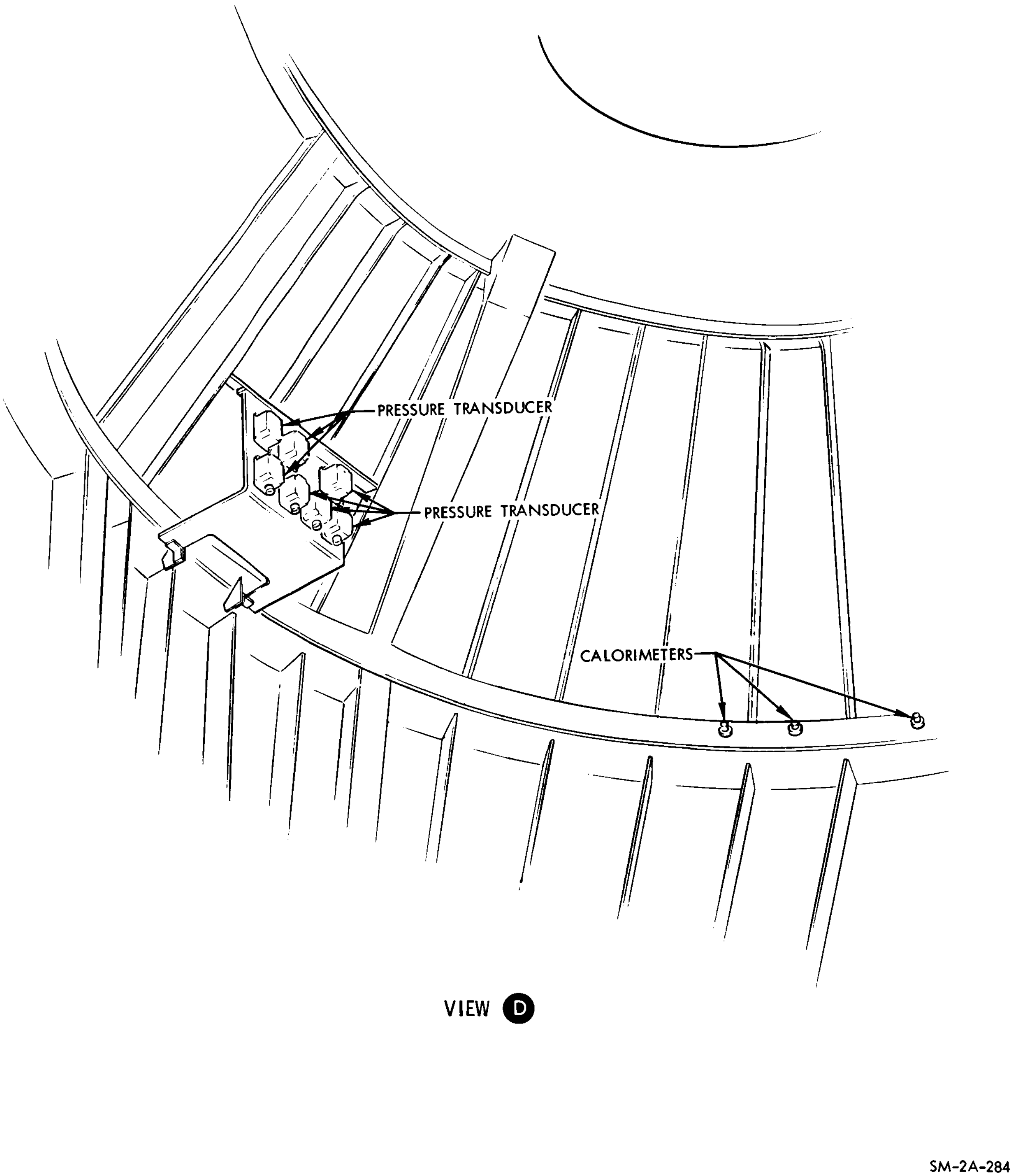



Figure 2-7. Command Module Interior (Sheet 4 of 5)

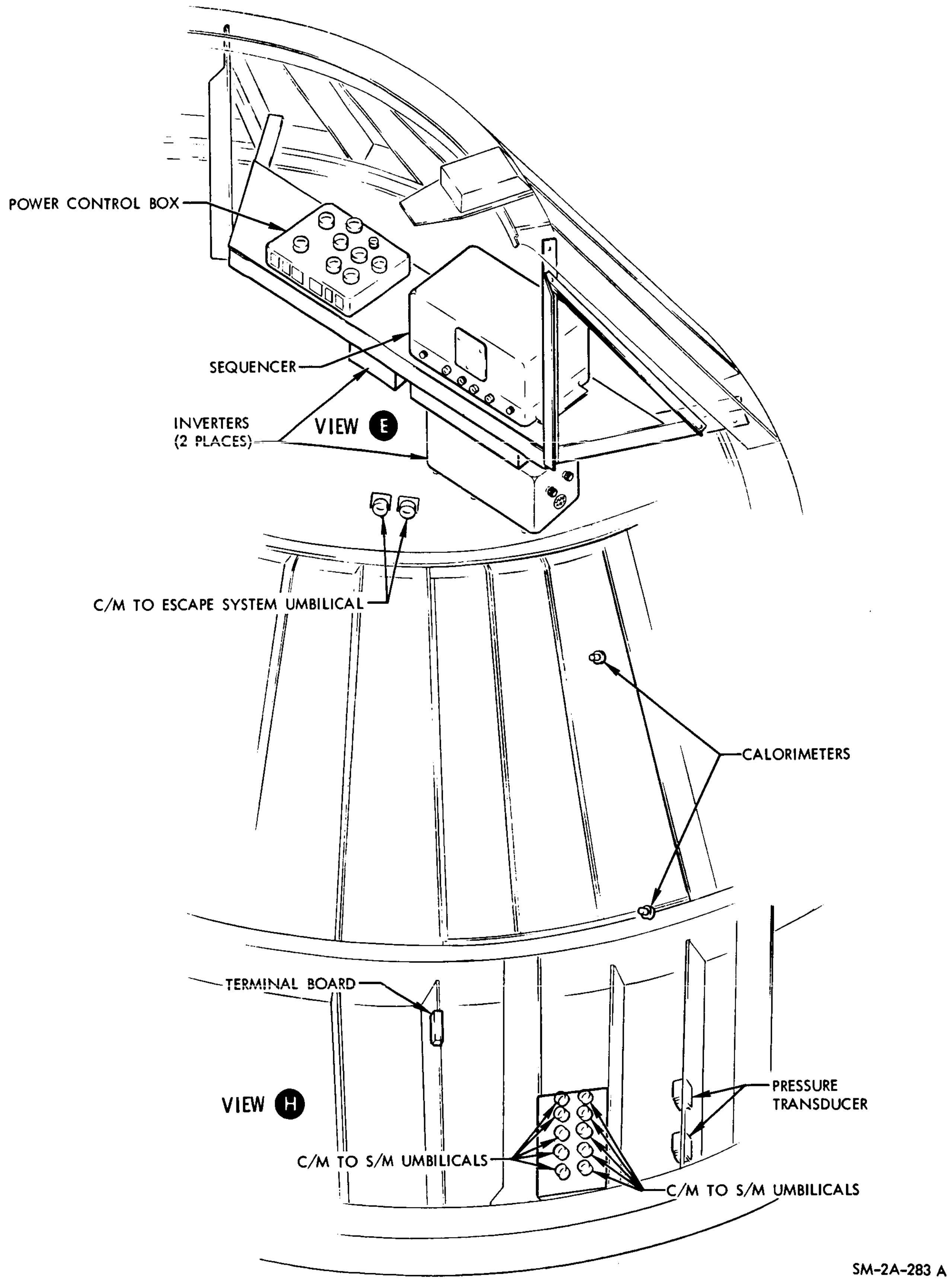



Figure 2-7. Command Module Interior (Sheet 5 of 5)

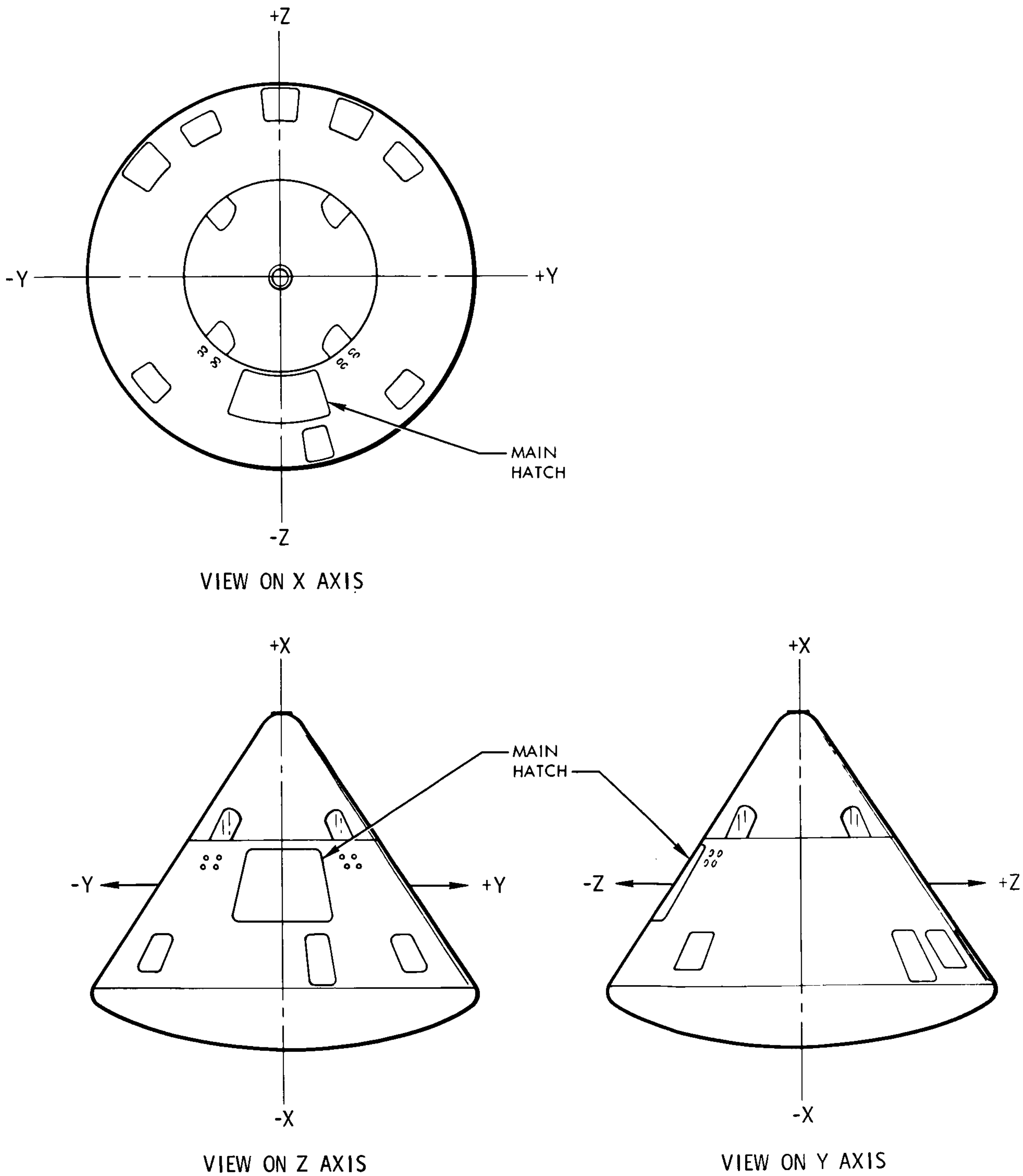



Figure 2-8. Command Module Reference Axis

Table 2-3. Command Module Compartmentation

| Compartment | Production Configuration Function | Boilerplate 13 Contents |
|---|---|---|
| Primary structure | Crew compartment | Launch escape tower sequencer, R&D communications, and instrumentation. Ballast to simulate weight and center of gravity. Egress tube to simulate production tube volume and main hatch. R&D cooling system. |
| Forward compartment | Houses parachute system of ELS, reaction thrust jets, and associated equipment | Radome and telemetry antenna. |
| Aft compartment | Houses dummy shock struts, environmental control system storage facilities, and C/M to S/M umbilicals | Aft heat shield attachment fittings, GSE attach fittings, umbilical connectors, equipment access doors, service module mating bearing pads, and tension ties. |

2-14. FORWARD HEAT SHIELD. The forward heat shield forms the apex of the command module. It consists of a sheetmetal cover and a fiberglass honeycomb radome assembled together, with the assembly bolted to the command module. There are no provisions for separating the forward heat shield, since recovery is not planned.

2-15. AFT HEAT SHIELD. The aft heat shield forms the convex base of the command module. It is constructed of aluminum honeycomb bonded to the inner and outer skins of the laminated fiberglass and is attached to the primary structure of the command module by four adjustable struts. Three of the struts are dummy shock struts (figure 2-9) installed at longerons No. 2, No. 3, and No. 4. The tension tie at No. 1 longeron contains a flange that allows it to be used as a dummy strut and a tension tie. Two holes are provided in the shield for installation of the umbilical electrical connectors. Six holes in the shield allow the command module bearing points to protrude, and three holes permit attachment of the command module to the service module. (See figure 2-11.)

2-16. <u>SERVICE MODULE, INSERT, AND ADAPTER.</u> (See figure 2-10.)

2-17. The service module includes the insert and is used in the boilerplate 13 configuration primarily to transmit loads from the launch vehicle to the spacecraft. The command module rests on the service module at six compression bearing points. Three tension-tie bolts hold the command module mating bearing points

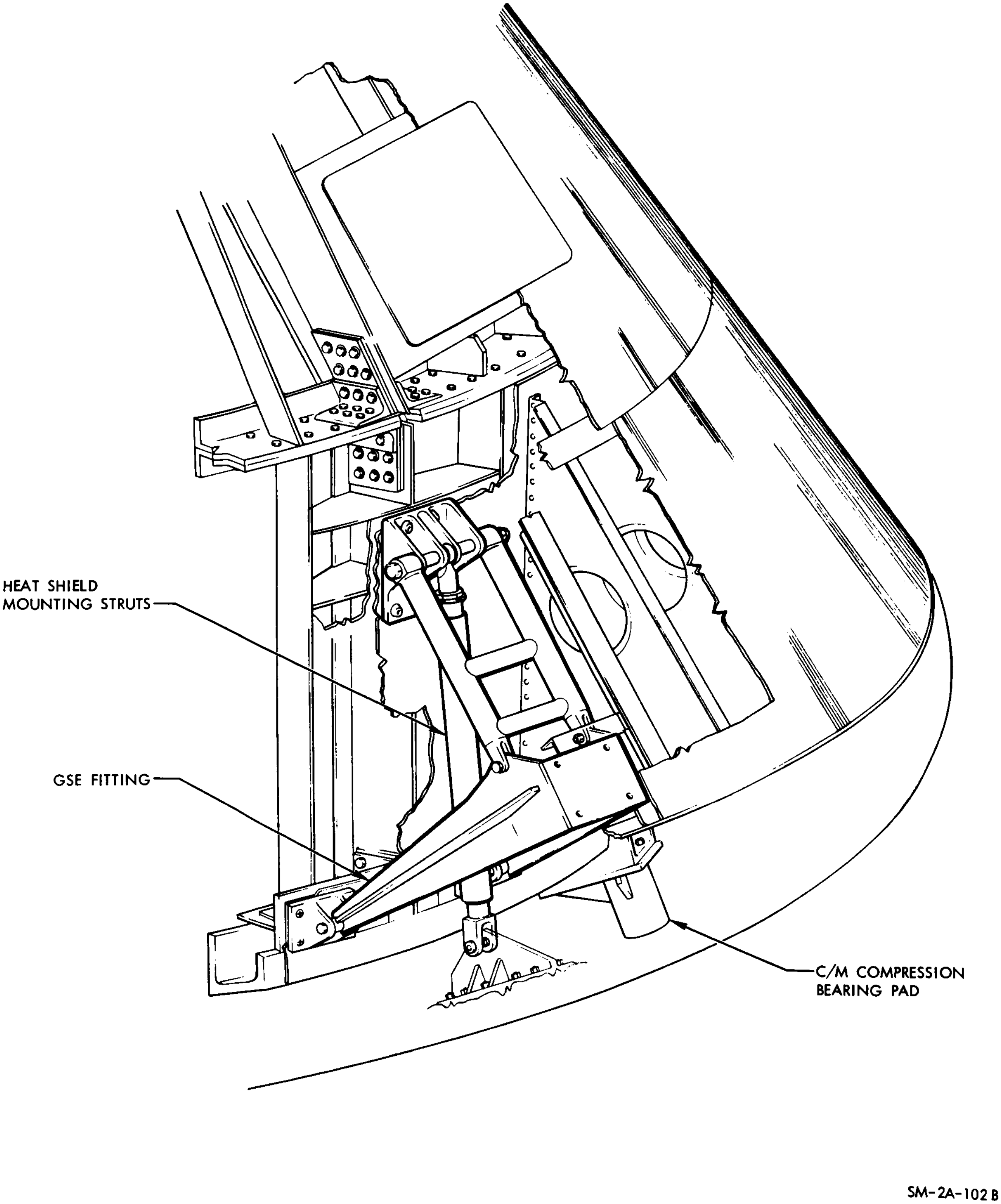



Figure 2-9. Dummy Shock Strut and GSE Attach Fitting

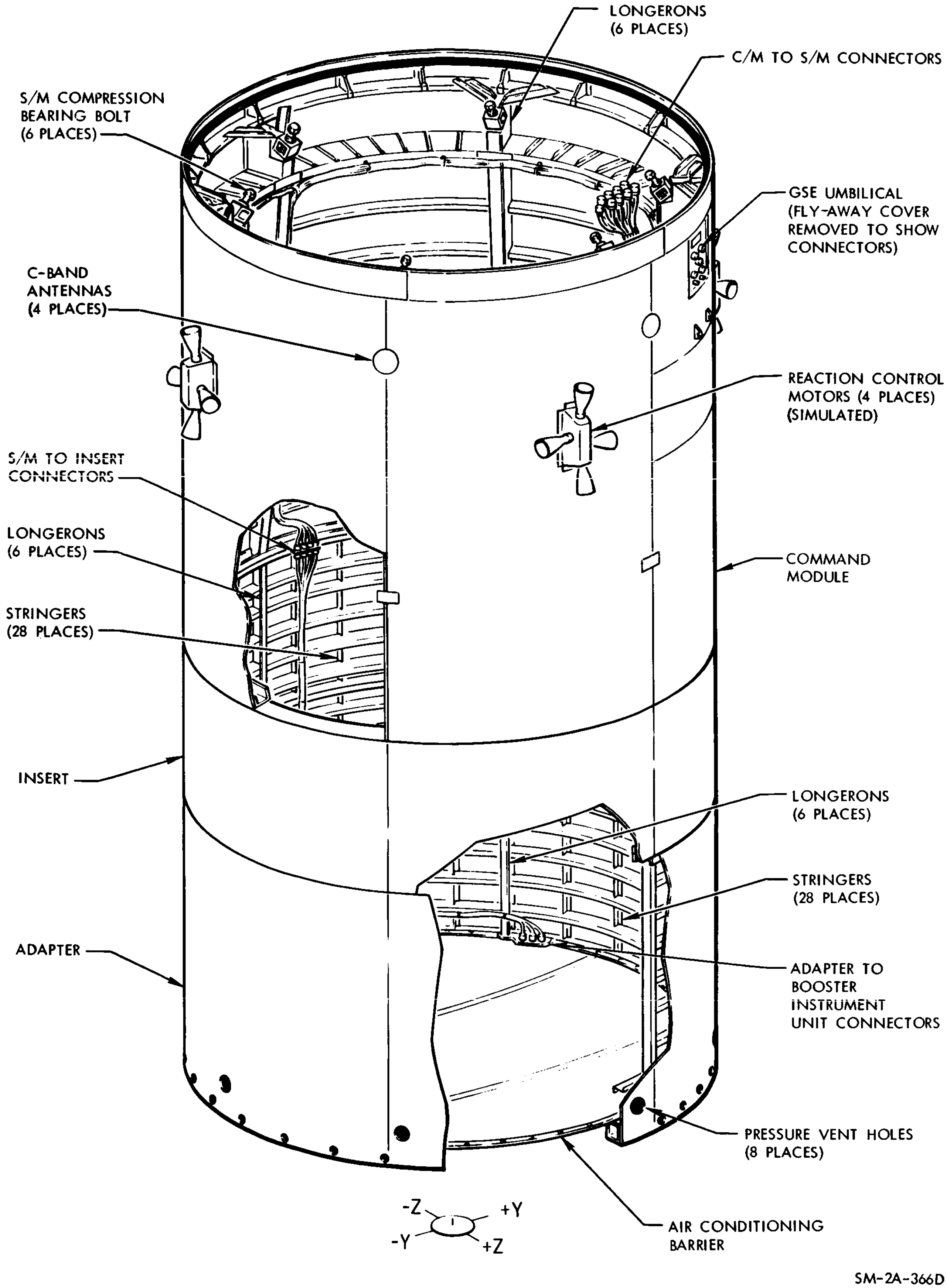



Figure 2-10. Service Module and Adapter

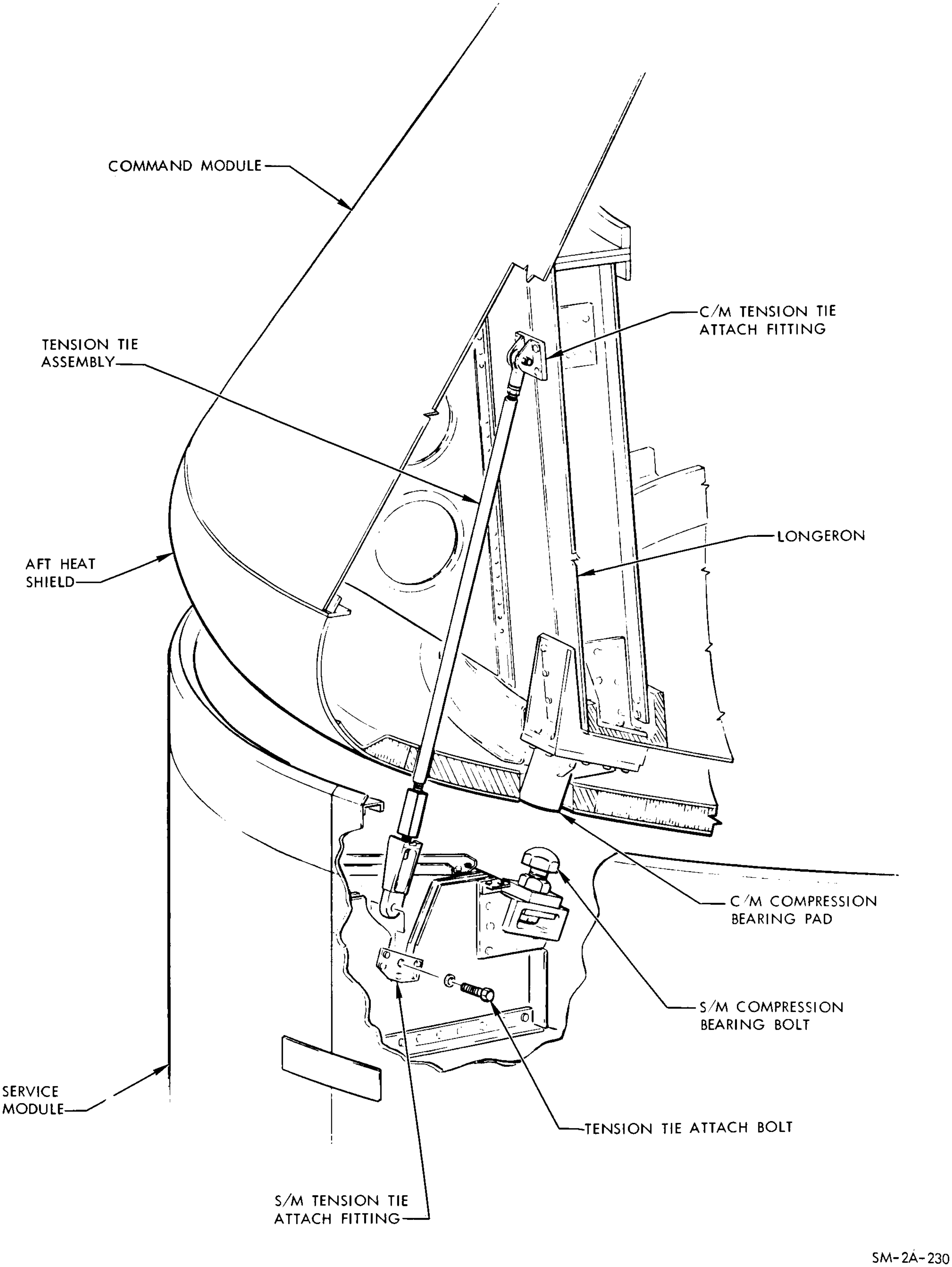



Figure 2-11. Service Module Tension Tie

firmly seated. The six bearing bolts are adjusted to facilitate command module-to-service module alignment. An exterior non-structural fairing is located between the command module and the service module. The fairing houses a non-functioning separation mechanism, a support structure for distributing basic loads imposed by the command module to the service module, and fixed umbilical connections between the two modules. The command module and service module will not be separated during the mission; and, therefore, no pyrotechnics are installed. The service module-to-insert and insert-to-adapter interfaces are joined with 24 bolts each. The adapter is bolted to the instrument unit using 32 bolts. The holes for these 32 bolts are cadmium plated to provide electrical bonding.

2-18. A part of the spacecraft instrumentation system is located in the service module as follows:

a. Service module (between stations 1785.596 and 1661.596, figure 1-1).

1. Seven calorimeters
2. Two strain gages
3. Twelve fluctuating pressure transducers
4. Three vibration transducers
5. Two accelerometers
6. One acoustical-sensing device.

b. Insert (between stations 1661.596 and 1609.596, figure 1-1).

1. One pressure transducer.

c. Adapter (between stations 1609.596 and 1517.596, figure 1-1).

1. Four strain gages
2. One calorimeter
3. Two vibration transducers.

2-19. Ballast is installed in the service module and adapter to simulate weight and center of gravity of the spacecraft. Reaction control system nozzles are mounted in place on the service module to simulate external configuration.

2-20. The adapter contains Apollo-Saturn interface wiring and an air conditioning barrier in addition to the instrumentation (paragraph 2-18). The air conditioning barrier consists of a double layer of nylon cloth impregnated on both sides with a chloroprene rubber compound. The barrier forms a bulkhead at the extreme aft end of the adapter.

2-21. STRUCTURE. The service module, insert, and adapter are cylindrical, of semimonocoque type structure, 154 inches in diameter, with an aluminum outer skin. The service module (less insert) is 124 inches in length. The skin is riveted to aluminum ring frames attached to six longerons. The longerons are T-shaped, the rim part being fabricated of steel and the web of aluminum.

2-22. The insert is 52 inches in length. The skin is riveted to upper and lower ring frames. The upper frame is composed of aluminum angles and webs riveted together; the lower frame is constructed of rectangular aluminum tubing. The upper and lower ring frames are riveted to six steel and aluminum longerons and 28 aluminum stringers.

2-23. The adapter is 92 inches in length. The skin is riveted to longerons and stringers. Eight holes in the aluminum skin, evenly spaced around the aft end of the adapter, provide venting for pressures which may build up in the adapter.

2-24. <u>INTERFACE EQUIPMENT.</u>

2-25. The interface equipment on boilerplate 13 consists of bolts, tension ties, and umbilical connectors. The umbilical connectors consist of electrical connectors and plugs located in the planes of separation of major components, and a GSE umbilical connector for ground support equipment.

2-26. COMMAND MODULE TO SERVICE MODULE TENSION TIE BOLTS. (See figure 2-11.)

2-27. The tension tie bolts utilized to bolt the command module to the service module are steel rod and turnbuckle assemblies. The assemblies are cadmium plated. The turnbuckle is used to preload the command module to the service module compression bearing points. The assemblies are approximately 42 inches long. Two of the assemblies use 7/8-inch hexagon steel rods 28.5 inches long. The third tie at longeron No. 1 uses 1-1/4-inch round steel rod 28.6 inches long on which hexagonal wrench flats have been machined. No pyrotechnic charges are installed on boilerplate 13 configuration. The tension tie at longeron No. 1 also is utilized as a vertical strut to help hold the aft heat shield in place.

2-28. UMBILICAL CONNECTORS.

2-29. The umbilical connectors on boilerplate 13 consist of electrical connectors and plugs located in the planes-of-separation of the modules, a GSE umbilical connector for ground support equipment, and a coolant umbilical connector.

These connectors join the electrical systems of the modules while the modules are attached and provide a means of disconnecting the electrical systems upon module separation. There is no requirement for module separation during boilerplate 13 mission; therefore, the necessary hardware for umbilical disconnect is omitted except for GSE separation. The GSE umbilical supplies the electrical power while the boilerplate is on the pad. The coolant umbilical supplies the fluid coolant from GSE equipment on the pad.

2-30. GSE UMBILICAL CONNECTOR. A GSE umbilical is located in the skin of the service module approximately 18 inches below the top, on the +Z-plane. (See figure 2-8.) This umbilical is equipped with a primary (pneumatic) and a backup (hydraulic) release mechanism. Both systems are armed by a signal from NASA control GSE. Pneumatic and hydraulic pressures are supplied by facility equipment. On initial command, a solenoid actuates the nitrogen pressure which ejects the umbilical. If this system fails to operate, 10 milliseconds later, a hydraulic actuator trips a lanyard which then disconnects the umbilical.

2-31. COMMAND MODULE TO SERVICE MODULE UMBILICAL CONNECTORS. Umbilical connector receptacles are recessed into the outer surface of the aft heat shield of the command module. They are approximately 12 inches from the outer edge and located near longeron No. 6. The receptacles are part of the command module aft compartment wiring installation. The plug portions of the connectors are part of the service module wiring installation.

2-32. SERVICE MODULE TO INSERT UMBILICAL CONNECTOR. Umbilical connector receptacles on the aft separation plane of the service module connect to plugs located in the extension forward end.

2-33. ADAPTER TO INSTRUMENT UNIT UMBILICAL CONNECTOR. Umbilical connector receptacles on the aft separation plane of the adapter connect to plugs located in the forward end of the booster instrument unit. The instrument unit will not be separated from the adapter.

2-34. LAUNCH VEHICLE. (See figure 1-1.)

2-35. The boilerplate 13 launch vehicle is a Saturn I configuration (designated SA-6) consisting of a Saturn S-I booster, a Saturn S-IV second stage, and a booster instrument unit.

2-36. The S-I stage is powered by eight Rocketdyne H-1 engines with a total thrust of 1, 500, 000 pounds. Propellants for these engines consist of 850, 000 pounds of oxidizer $LO_2$ and fuel RP-1. The general appearance is cylindrical with aerodynamic stabilizing fins at the extreme aft end of the cylinder. The airframe is approximately 21 feet in diameter and is approximately 80 feet in length. First stage engine cutoff is at 150.92 seconds after ignition. An S-I/S-IV interstage section 18 feet in diameter is jettisoned with the first stage.

2-37. The S-IV stage is powered by six Pratt & Whitney RL10-A3 engines with a total thrust of 90,000 pounds. Propellants for these engines consist of 100,000 pounds of oxidizer $LO_2$ and fuel $LH_2$. The airframe is approximately 18 feet in diameter with the forward end tapering to 13 feet to interface with the instrument unit and the spacecraft. The S-IV booster burns 464 seconds, placing the booster, instrument unit, and spacecraft into a 90- to 120-mile orbit. No recovery is planned.

2-38. The instrument unit interfaces with the booster and spacecraft. It is approximately 13 feet in diameter and contains the guidance and control system, flight sequencers, telemetry system, tracking system, and electrical power system.

# SECTION III

# LAUNCH ESCAPE SYSTEM

## 3-1. PURPOSE.

3-2. The boilerplate 13 launch escape system will demonstrate the structural adequacy of the design by the static and dynamic loads imposed while on the ground, and during lift-off and boost phases.

## 3-3. OPERATIONAL DESCRIPTION.

3-4. The prototype launch escape system for boilerplate 13 is structurally similar to those used throughout the program; the launch escape motor and pitch control motor are inert. (See figure 2-1.) Tower jettison is initiated 12 seconds after S-I/S-IV separation by a booster flight programer, at an altitude of approximately 266,300 feet. Figure 3-1 is a functional block diagram showing sequence of events. Table 3-1 is a time history of the events leading to tower jettison.

Table 3-1. Time History of Events Leading to Tower Jettison

| Time (Seconds from Ignition) | Event | Velocity (Feet/Second) | Altitude (Feet) | Dynamic Pressure (Pounds/Foot$^2$) | Flight Path Angle (Deg) | Range (KM) | Mach No. |
|---|---|---|---|---|---|---|---|
| T + 0 | S-I ignition | 0 | 0 | 0 | | 0 | 0 |
| T + 3.42 | Lift-off | | | | 90 | | |
| T + 72.92 | Max Q | 1595 | 41,292 | 760 | 53 | | 1.65 |
| T + 145.12 | S-I inboard Eng. cutoff | | 197,502 | 22.4 | | | |
| T + 151.12 | S-I burnout | 8741 | 222,409 | 10.0 | 24 | 50 | 8.98 |
| T + 154.12 | S-IV ignitior | 8707 | 232,043 | 6.64 | 24 | 55 | 9.22 |
| T + 164.12 | Escape tower jettison | 8800 | 266,300 | | 21.9 | 67 | |

## 3-5. TOWER JETTISON MOTOR IGNITION.

3-6. The tower jettison motor ignition system contains two electrical hot wire initiators threaded into pyrotechnic cartridges which fire the motor igniter. Redundant initiators are employed for increased reliability. Current passing through low resistance wires detonates the cartridge, which in turn ignites the rocket motor igniter. The initiator body is 1 inch long with a 3/4-inch flange,

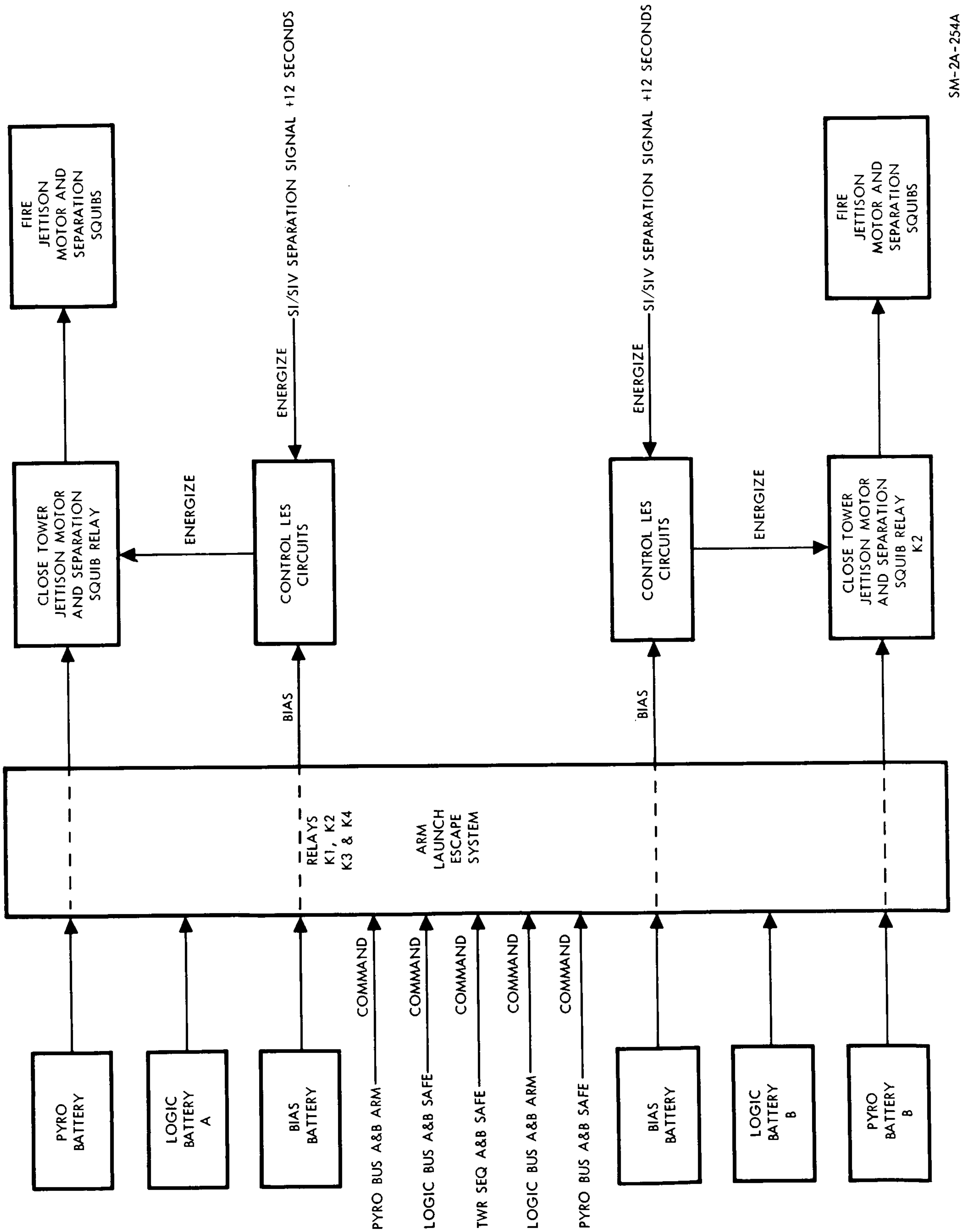



Figure 3-1. Launch Escape System Functional Block Diagram

0.45 inch from the threaded end. The electrical header contains two independent hot wire circuits and four pins. The initiator ignites within 10 milliseconds when one bridge wire is subjected to a firing current of 3.5 amperes. The pressure level of the explosive charge is produced within 12 milliseconds after application of current. The igniter for the tower jettison motor is installed in the aft dome of the rocket motor.

3-7. TOWER SEPARATION.

3-8. The tower separation system consists of four explosive bolts that secure the tower to the command module (figure 2-2). The explosive bolt charge is contained in the center of the bolt and shatters the bolt when detonated. Release of the tower is accomplished by simultaneous detonation of the four explosive bolts. The hot wire initiators for the bolts are ignited by 28-volt d-c signals received from the mission sequencer through the tower sequencers. The initiators will detonate to fire the explosive bolts within 5 milliseconds. To accomplish tower jettison, the mission sequencer simultaneously initiates detonating signals to the explosive bolts and to the tower jettison motor hot wire initiators. The entire launch escape assembly is released and pulled clear of the spacecraft trajectory. The tower to command module umbilical connections are disconnected automatically when tower separates from the command module.

3-9. LAUNCH ESCAPE MOTOR.

3-10. Boilerplate 13 uses an inert launch escape motor which contains ballast to simulate the weight of a live launch escape rocket motor. The motor will weigh approximately 4800 pounds with ballast installed. (See figure 2-1.)

3-11. PITCH CONTROL MOTOR.

3-12. Boilerplate 13 uses an inert pitch control motor which contains ballast to simulate the weight of a live pitch control motor. The motor weighs approximately 47 pounds with ballast installed. (See figure 2-1.)

3-13. LAUNCH ESCAPE TOWER JETTISON MOTOR.

3-14. The tower jettison motor is a solid-propellant motor that provides the thrust for separation of the launch escape tower and related equipment from the command module. The jettison motor is mounted on top of the inert escape motor. Passive thrust vector control in the form of offset exhaust nozzles provide a trajectory that arcs slightly in the pitch-up direction. For operational characteristics of the jettison motor, refer to table 3-2.

Table 3-2. Operational Characteristics of Launch Escape Tower Jettison Motor

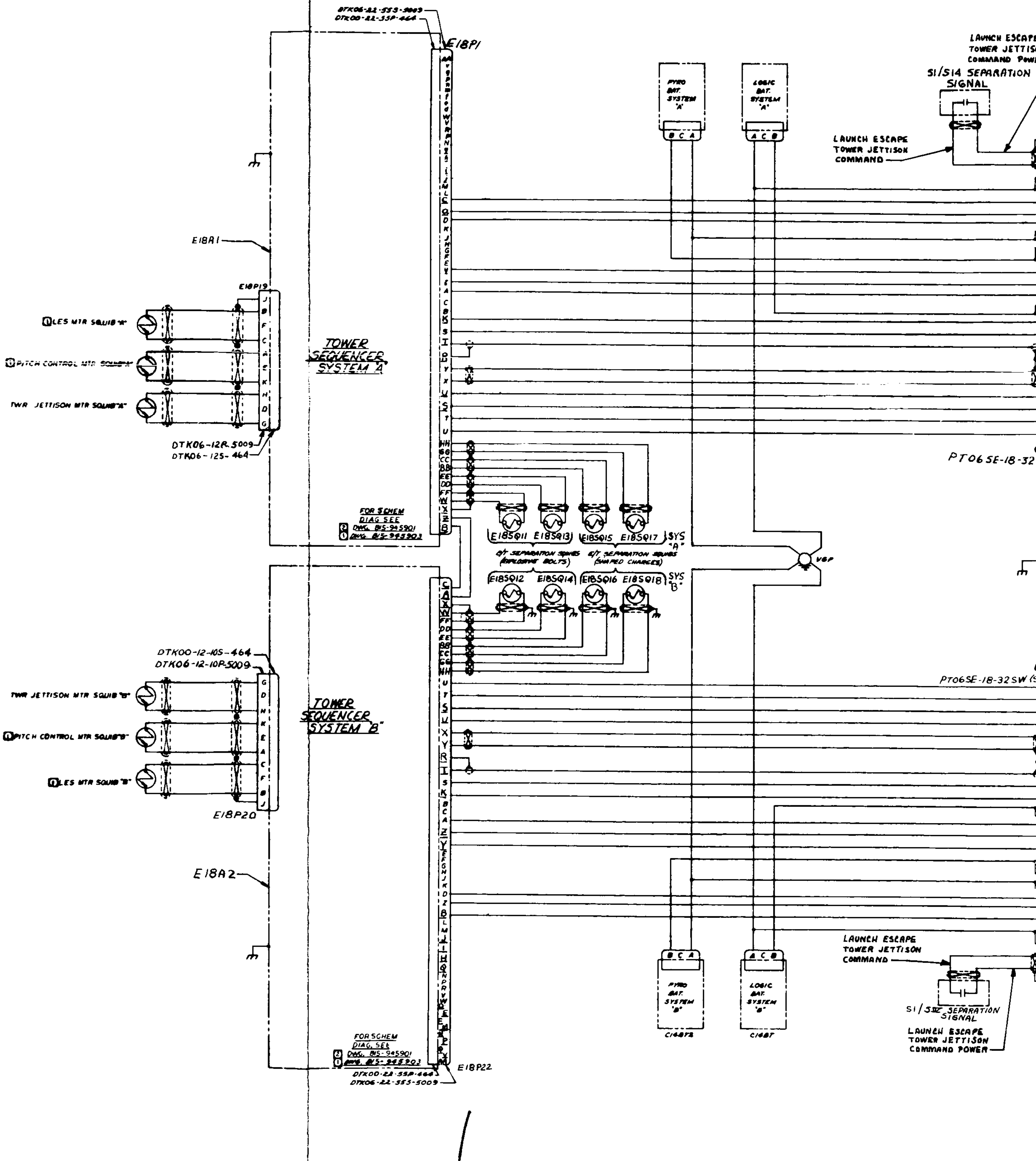
| | |
|---|---|
| Thrust | 31,600 pounds |
| Duration | 1.07 second |
| Time required to reach 90-percent maximum thrust | 75 to 125 milliseconds |
| Angles between resultant thrust axis and motor: | |
| Pitch plane | 2 degrees 30 minutes ±30 minutes |
| Yaw plane | 0 degrees ±30 minutes |

3-15. MISSION SEQUENCER. (See figures 2-7 and 3-2.)

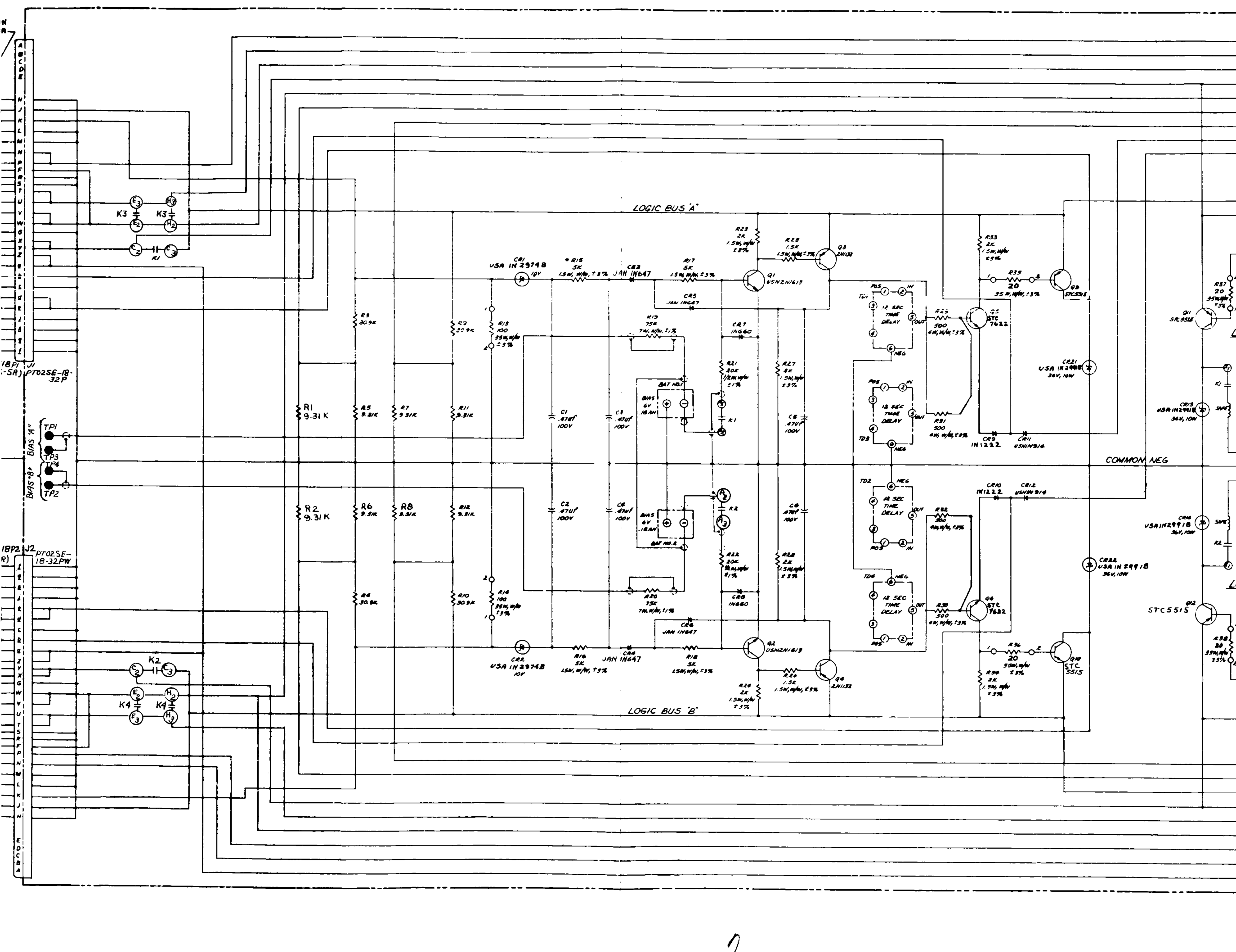
3-16. The mission sequencer located in the command module controls the sequence of events that are necessary to execute a successful launch escape tower jettison operation. The sequencer contains the logic circuits to direct the timing and order of the electrically initiated steps of the mission. Complete redundance of the entire sequential network is provided for added reliability. The mission sequencer logic circuits send the electrical signals to operate the motor switches in the tower sequencer. The switches then allow electrical power from the pyro bus to simultaneously fire the explosive bolt squibs and ignite the tower jettison motor. Table 3-3 gives mission sequencer functions. In addition, the mission sequencer provides compatibility of monitoring critical events as they occur, thus providing an input to the instrumentation system.

3-17. TOWER SEQUENCERS. (See figures 2-3 and 3-3.)

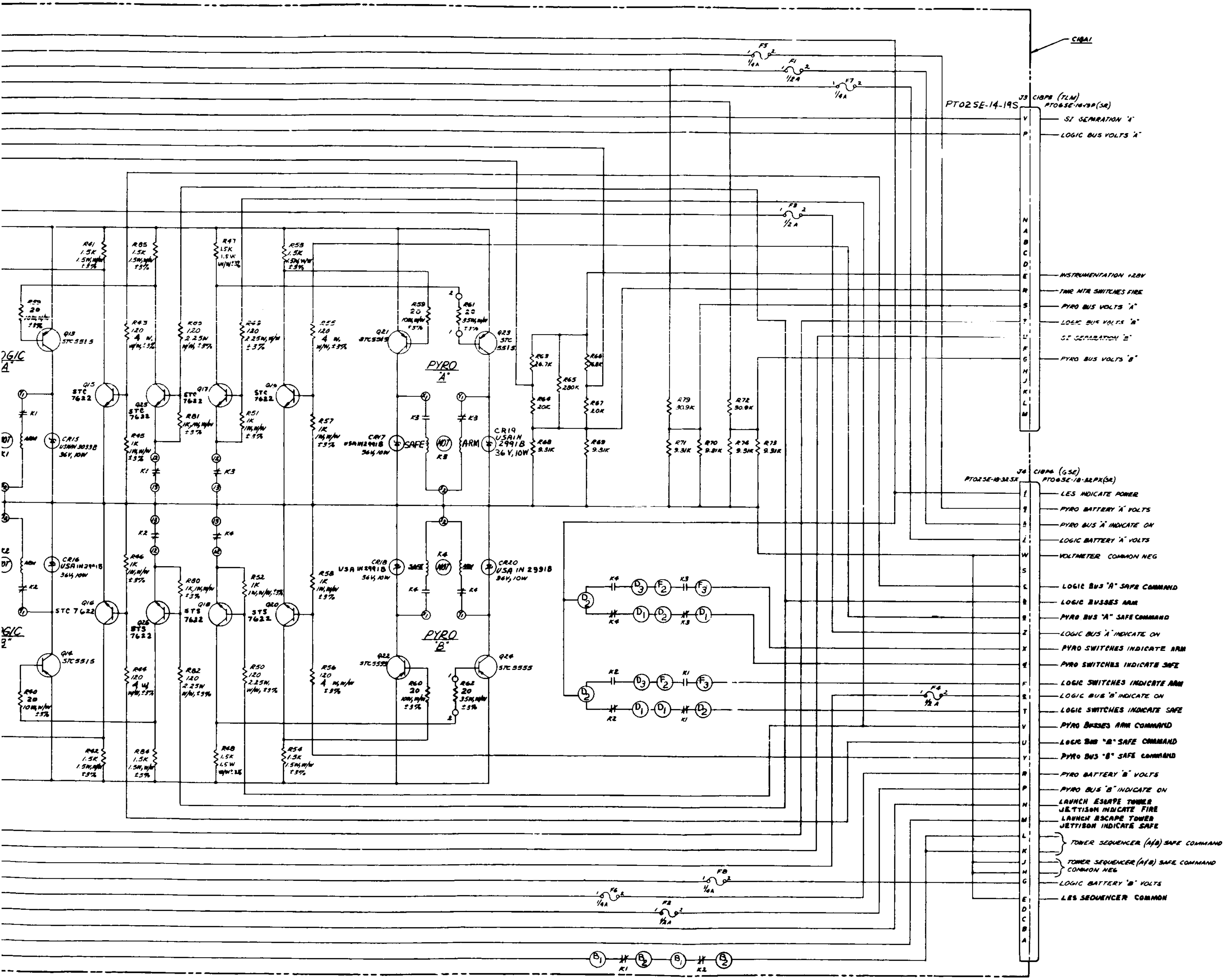
3-18. Two tower sequencers are attached to the underside of the structural skirt. Each sequencer has one motor-driven switch. An output voltage from the mission sequencer drives each motor-driven switch to the ARM position. The switches then allow electrical power from the pyro bus to simultaneously fire the tower separation explosive bolts and ignite the jettison motor. The sequencer provides circuits for monitoring the functional status of the control circuits via GSE during checkout operations. Use of two sequencers provides total redundancy for added reliability.



E18P1
E18A1
E18P19
LES MTR SQUIB "A"
PITCH CONTROL MTR SQUIB "A"
TWR JETTISON MTR SQUIB "A"
DTK06-12R-5009
DTK06-12S-464
TOWER SEQUENCER SYSTEM "A"
FOR SCHEM DIAG SEE DWG. BIS-945901 DWG. BIS-945903
PYRO BAT. SYSTEM "A"
LOGIC BAT. SYSTEM "A"
LAUNCH ESCAPE TOWER JETTISON COMMAND
S1/S14 SEPARATION SIGNAL
E18SQ11 E18SQ13 E18SQ15 E18SQ17 SYS "A"
E18SQ12 E18SQ14 E18SQ16 E18SQ18 SYS "B"
VGP
PT06SE-18-32
PT06SE-18-32SW
DTK00-12-10S-464
DTK06-12-10P-5009
TWR JETTISON MTR SQUIB "B"
PITCH CONTROL MTR SQUIB "B"
LES MTR SQUIB "B"
E18P20
TOWER SEQUENCER SYSTEM "B"
E18A2
PYRO BAT. SYSTEM "B"
LOGIC BAT. SYSTEM "B"
C14872
C1487
LAUNCH ESCAPE TOWER JETTISON COMMAND
LAUNCH ESCAPE TOWER JETTISON COMMAND POWER
E18P22


LOGIC BUS "A"
LOGIC BUS "B"
COMMON NEG
PT02SE-18-32P
PT02SE-18-32PW
BIAS "A"
BIAS "B"
TP1
TP2
TP3
TP4
R1 9.31 K
R2 9.31 K
K3
K2
K4
12 SEC TIME DELAY
STC 5515
USA IN 2991B
USA IN 2974B
JAN IN647


2



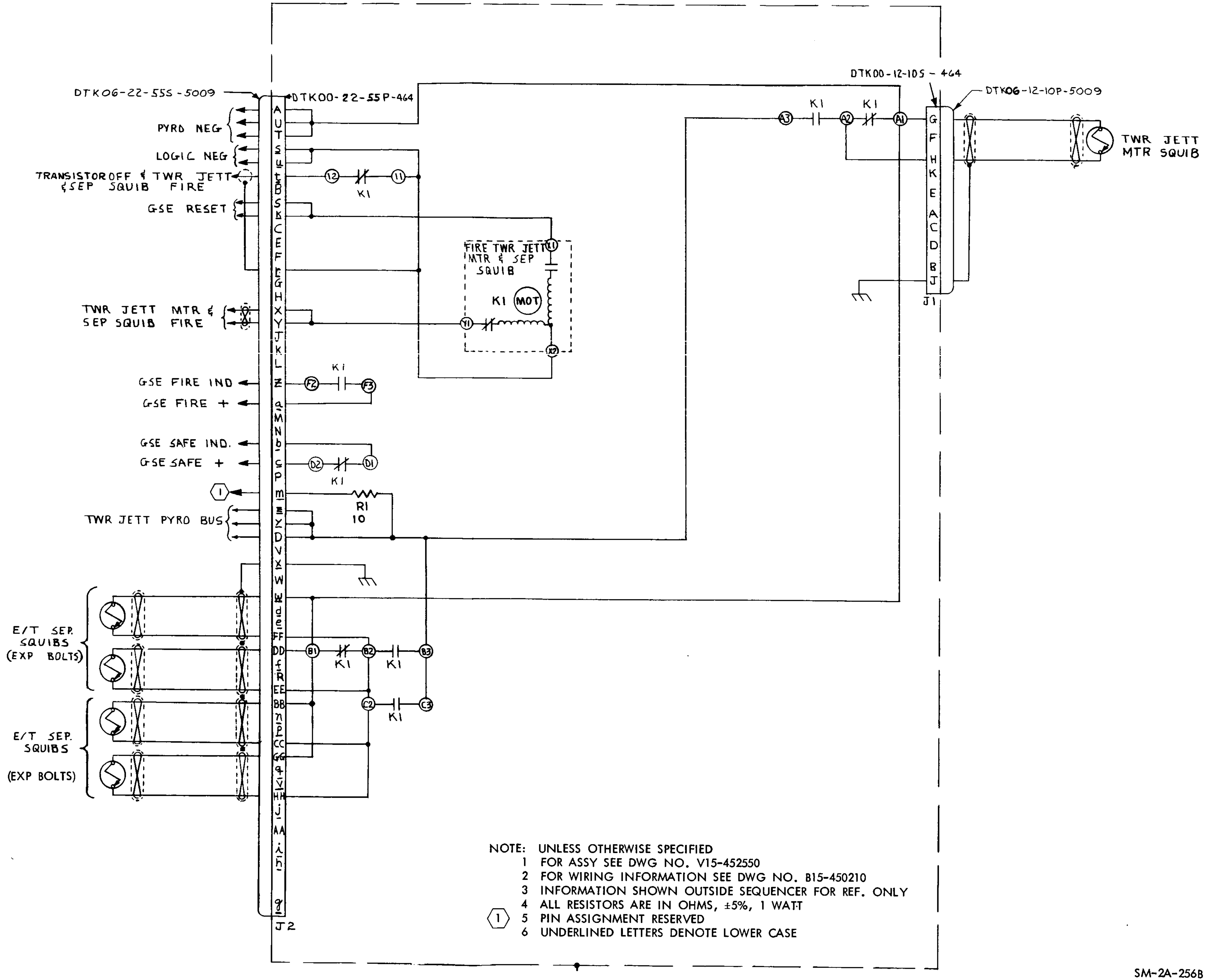
SM-2A-255B

Figure 3-2. Mission Sequencer Schematic Diagram

3

Table 3-3. Mission Sequencer Functions

| Signal | Function | Time | Controlling Components | Signal Source |
|---|---|---|---|---|
| Logic bus A & B arm command | Supplies base voltage for transistorized switching network to energize coils of motor-driven switches C18K1 and C18K2. | Prelaunch | C18J4-b | GSE |
| Logic bus A & B | Supplies collector voltage to transistorized switching network to energize coils of motor-driven switches E18K1 and E18K2 and for arming of S-I separation signal. | Prelaunch | C18K1 and C18K2, C18J4-X, C18J4-Y, C18J2-X, and C18J2-Y | Logic batteries A and B |
| Pyro bus A & B arm command | Supplies base voltage for transistorized switching network to energize coils of motor-driven switches C18K3 and C18K4. | Prelaunch | C18J4-V | GSE |
| Pyro bus A & B | Supplies voltage to firing contacts of E18K1 and E18K2. | Prelaunch | C18K3 and C18K4, C18J1-T, C18J1-U, C18J2-T, and C18J2-U | Pyro batteries A |
| S-I separation | Supplies base voltage to transistorized switching network to energize coils of motor-driven switches E18K1 and E18K2. | S-I separation plus 12 seconds | IU programmer C18J1-J, C18J1-K, C18J2-J, and C18J2-K | Logic bus A and B |
| Launch escape tower jettison | Supplies firing voltage to tower jettison motor and launch escape tower separation squib initiators. | S-I separation plus 12 seconds | E18K1 and E18K2 | Pyro bus A and B |




NOTE: UNLESS OTHERWISE SPECIFIED
1 FOR ASSY SEE DWG NO. V15-452550
2 FOR WIRING INFORMATION SEE DWG NO. B15-450210
3 INFORMATION SHOWN OUTSIDE SEQUENCER FOR REF. ONLY
4 ALL RESISTORS ARE IN OHMS, ±5%, 1 WATT
(1) 5 PIN ASSIGNMENT RESERVED
6 UNDERLINED LETTERS DENOTE LOWER CASE

Figure 3-3. Tower Sequencer Schematic Diagram

# SECTION IV

# COMMUNICATIONS AND INSTRUMENTATION

## 4-1. PURPOSE.

4-2. The communications and instrumentation system provides a means of acquiring and conditioning preselected information and of transmitting this information to earth monitoring equipment. (Refer to table 4-1 for measurement list.) The system also provides for tracking of the spacecraft during the mission. The Q-ball contains some instrumentation equipment, the information being used for booster guidance system performance evaluation. The Q-ball system is not connected functionally with the Apollo communications and instrumentation system, but is described in this section.

## 4-3. DESCRIPTION. (See figure 4-1.)

NOTE

For detailed descriptive and checkout information for the R&D electronic equipment furnished by NASA, refer to applicable NASA manuals.

4-4. COMMUNICATIONS EQUIPMENT.

4-5. Communications R&D equipment consists of the telemetry system and radar transponders.

4-6. TELEMETRY SYSTEM. The telemetry system consists of three FM/FM telemetry subsystems; one subsystem containing two PAM channels, the transmitters of each operating into the antenna system. In addition to the transmitter, each telemetry subsystem includes subcarrier oscillators. Subsystem A contains a 90 by 10 and a 90 by 1-1/4 commutator. The 90 by 1-1/4 commutator is used for temperature measurements.

4-7. Transmitting frequencies of the three systems are as follows:

| | |
|---|---|
| Telemetry system A | 237.8 mc |
| Telemetry system B | 247.3 mc |
| Telemetry system C | 257.3 mc |

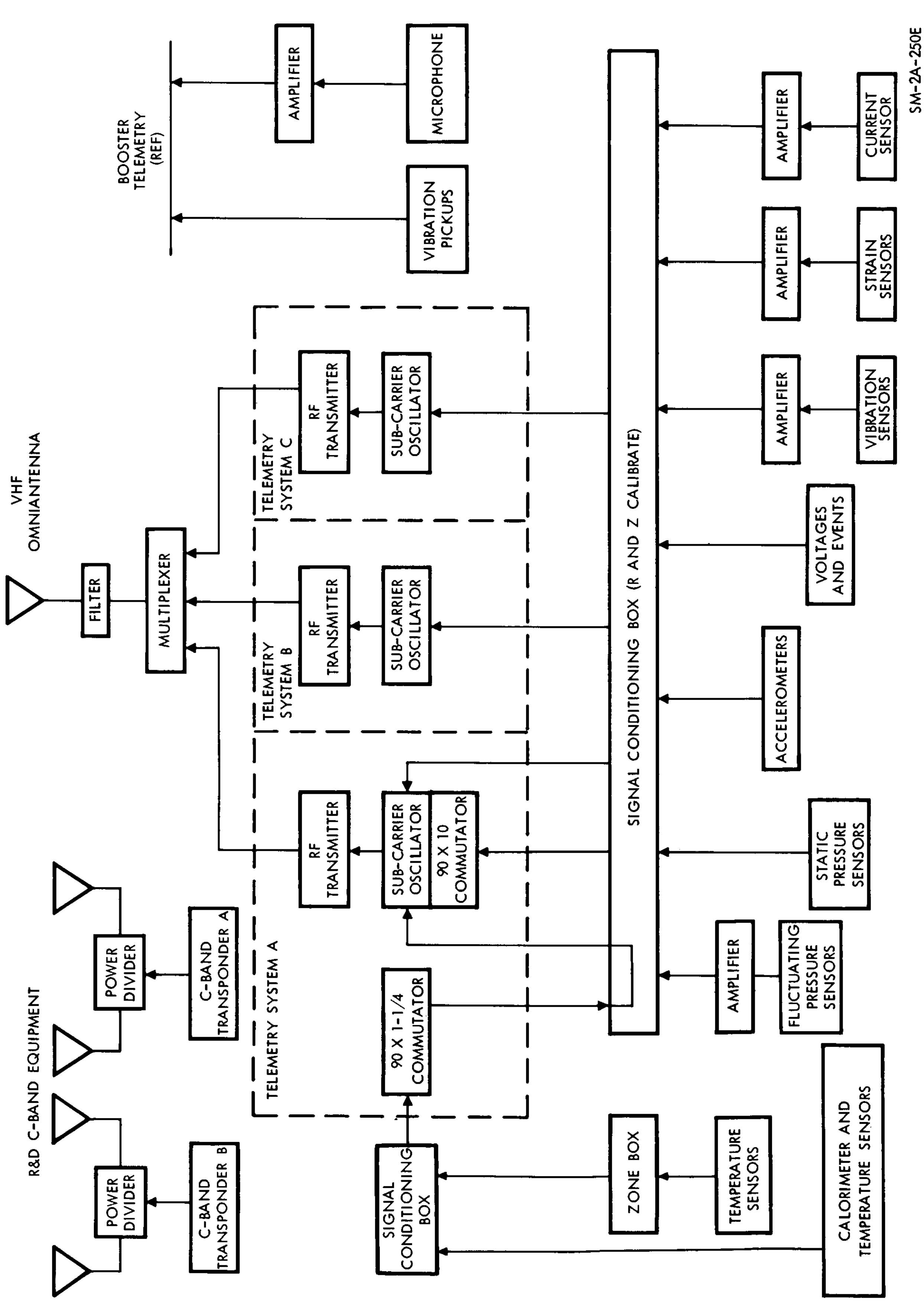



Figure 4-1. R&D Instrumentation Block Diagram

4-8. The antenna system consists of a multiplexer, a filter, and VHF omniantenna. The antenna is located under a radome in the nose of the command module.

4-9. RADAR TRANSPONDERS. The two radar transponders operate in the C-band frequency range, receiving at 5690 mc and transmitting at 5765 mc. The transponders are interrogated by a 2-pulse code spaced at intervals of 3.5 microseconds between leading edges, and the return pulses follow after a 2.0 microsecond delay. The repetition rate will be consistent with range tracking requirements.

4-10. The radar transponder antenna system includes two power dividers and four cavity-helical, flush-mounted antennas. The antennas are mounted 90 degrees apart around the upper section of the service module.

4-11. INSTRUMENTATION EQUIPMENT.

4-12. Instrumentation equipment includes the necessary transducers, sensors, and other devices to monitor physical and thermal effects of flight upon the spacecraft and to convert them into electrical signals suitable for telemetering. The devices are located in and on the spacecraft as shown in figure 4-2. Table 4-1 consists of identification number, measurement description, channel, data range, priority, response, and device location. Subheadings in the Channel columns indicate the following: LK (link) designates the telemetry (r-f carrier) package A, B, or C; SC No. (subcarrier number) designates telemetry channels 1 through 18, and Com Seg (commutator segment) designates the telemetry commutator segment assigned to the measurement for that vehicle. LV TM (launch vehicle telemetry), which appears in the Channel LK and SC No. columns, designates a measurement to be telemetered by launch vehicle telemetry. The Data Range columns denote minimum and maximum values for a parameter in engineering units. The following letters in the PR (priority) column indicate how critical the measurement: P (primary) denotes measurements that must be available at launch for mission success and to meet the flight objectives; S (secondary) denotes measurements that are highly desirable, but will not abort or delay the mission if inoperative; and M (multiple) designates a group of measurements of which only a specified percentage may be inoperative. The Response column denotes the rate and unit required to provide satisfactory data resolution to time or waveform. Response for continuous data monitoring (telemetry or recorder) is specified in cycles per second (cps), and sampled-data monitoring (PCM or PACE) is specified in samples per second (S/S). The Location column refers to the coordinates which denote the physical location within the spacecraft where the measurement is taken.

4-13. SIGNAL CONDITIONING. The signal conditioning equipment adapts all signals received from the measurement sensors to the telemetry signal input requirements and also directs the conditioned signal to the proper telemetry system. R- and Z-calibration command circuitry is included in the signal conditioner unit. Z (zero) is equal to 15 percent of full-scale signal and R (range) is equal to 85 percent of full-scale range.

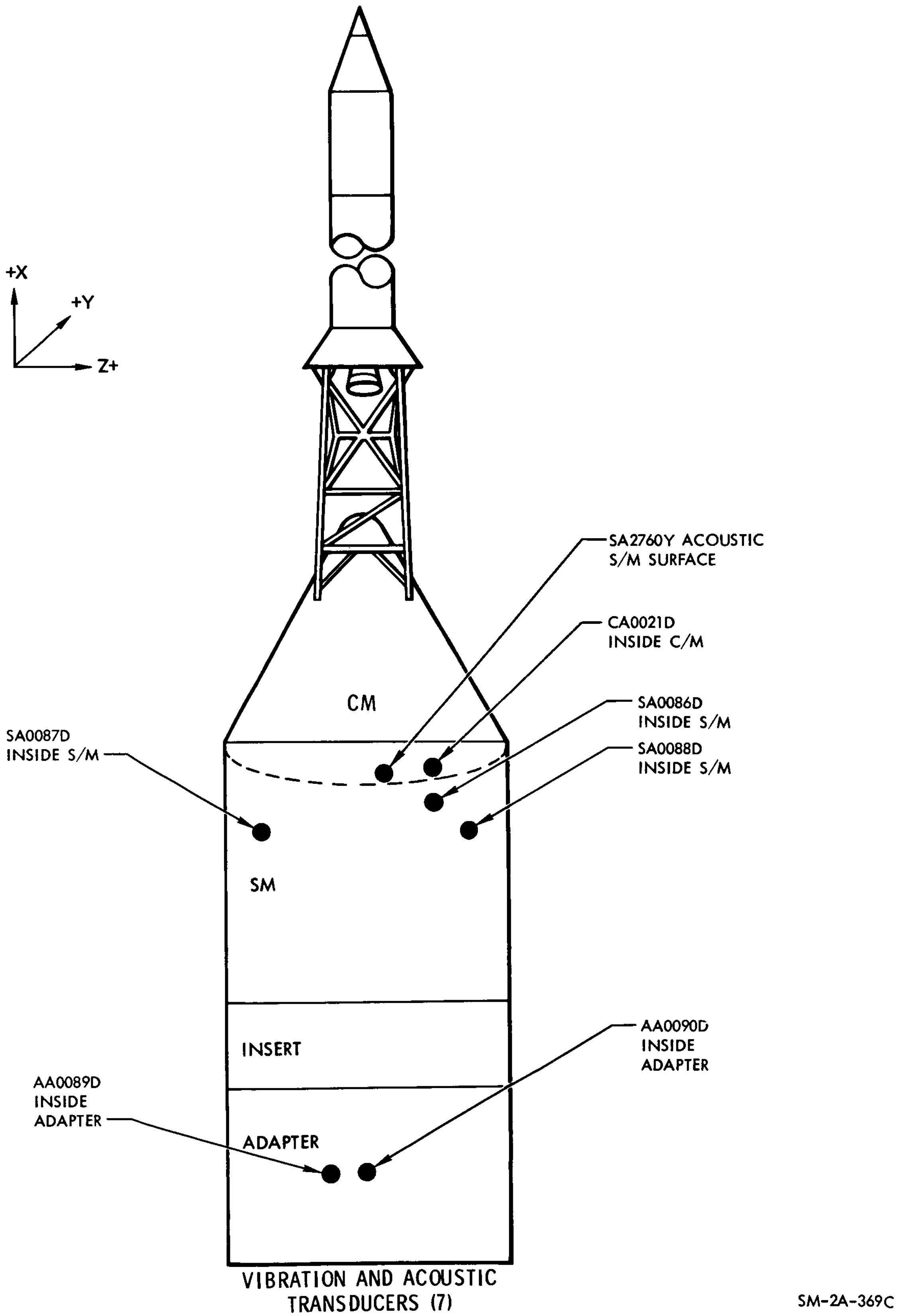



Figure 4-2. R&D Instrumentation Locations (Sheet 1 of 6)

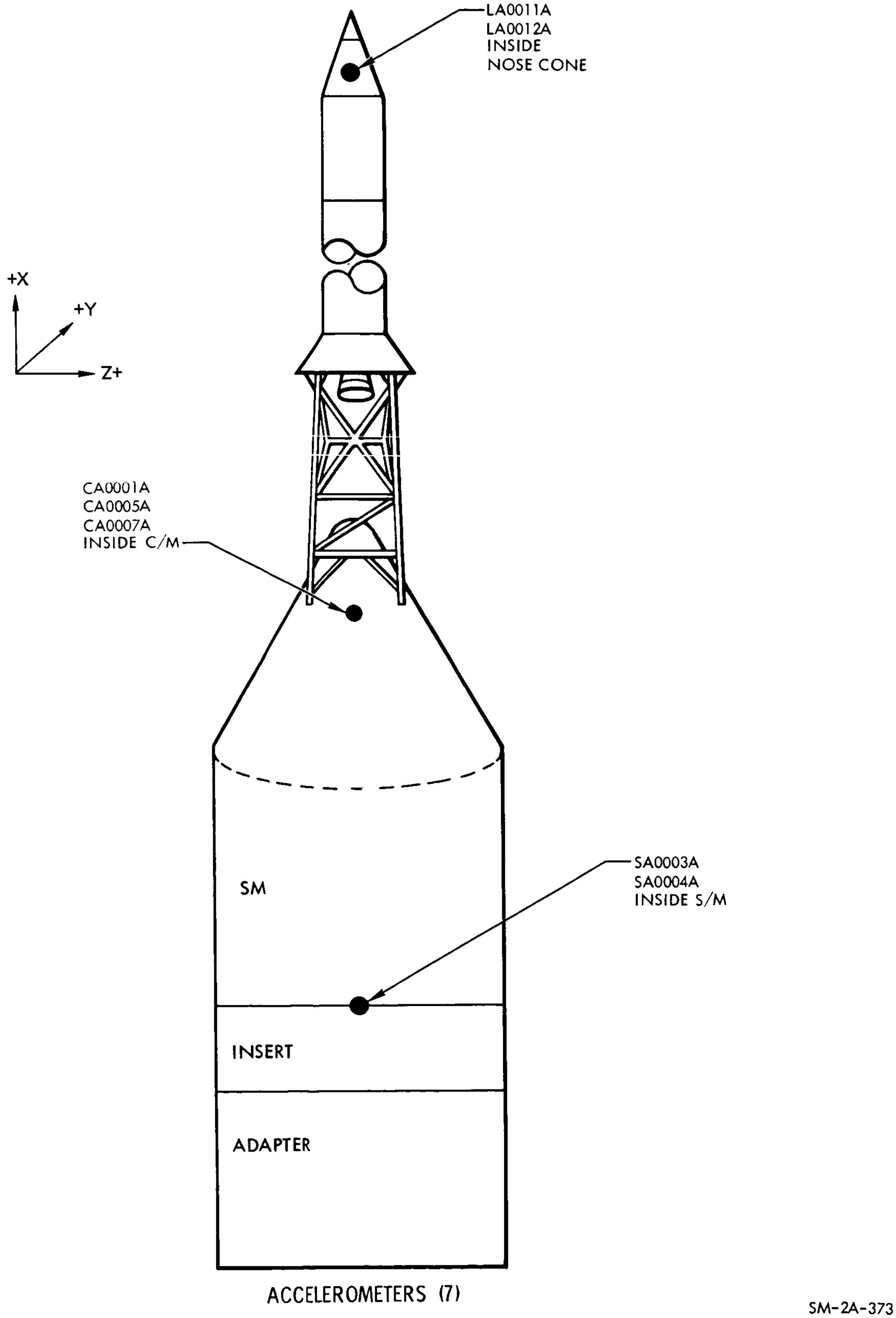



Figure 4-2. R&D Instrumentation Locations (Sheet 2 of 6)

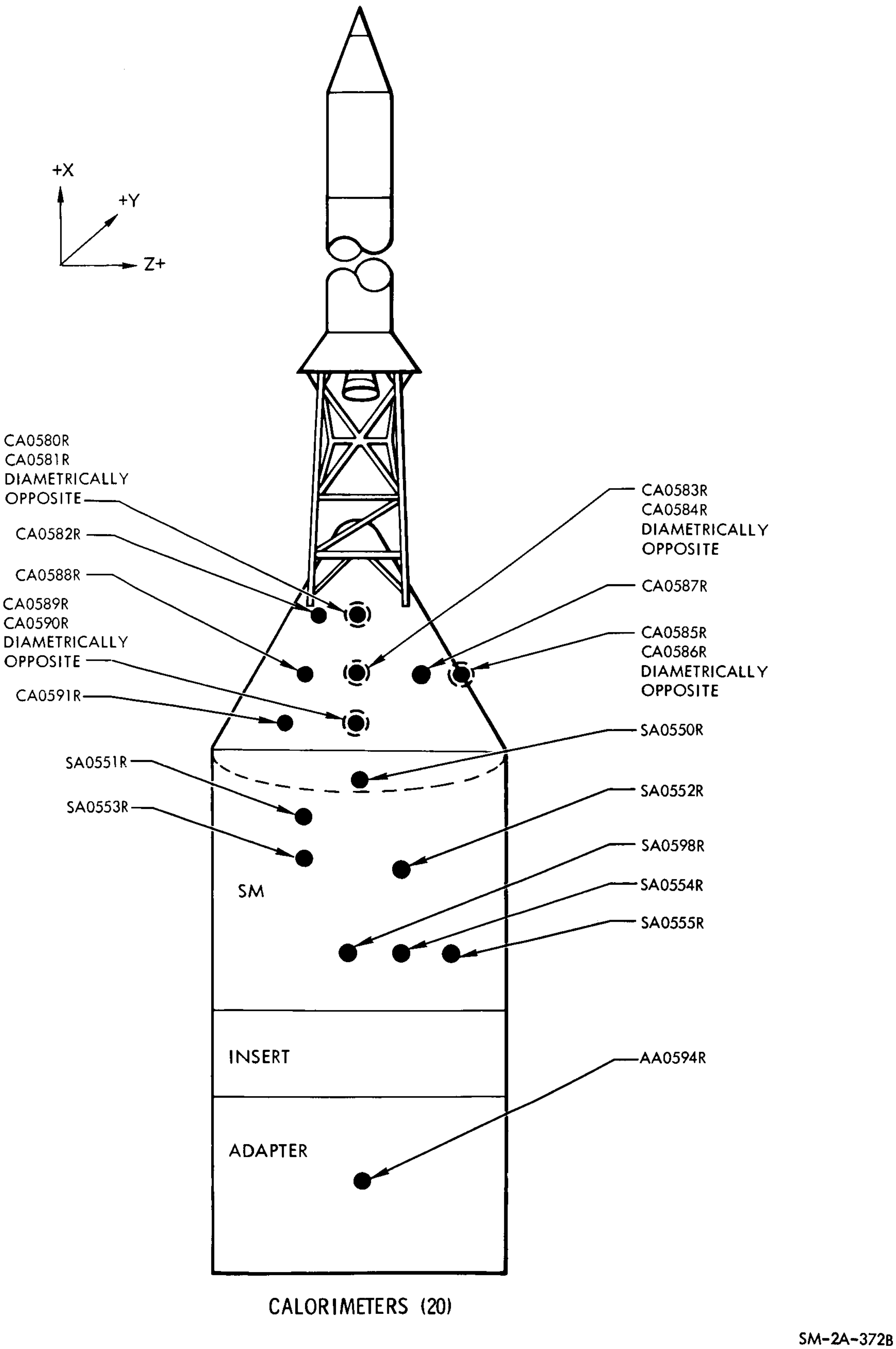
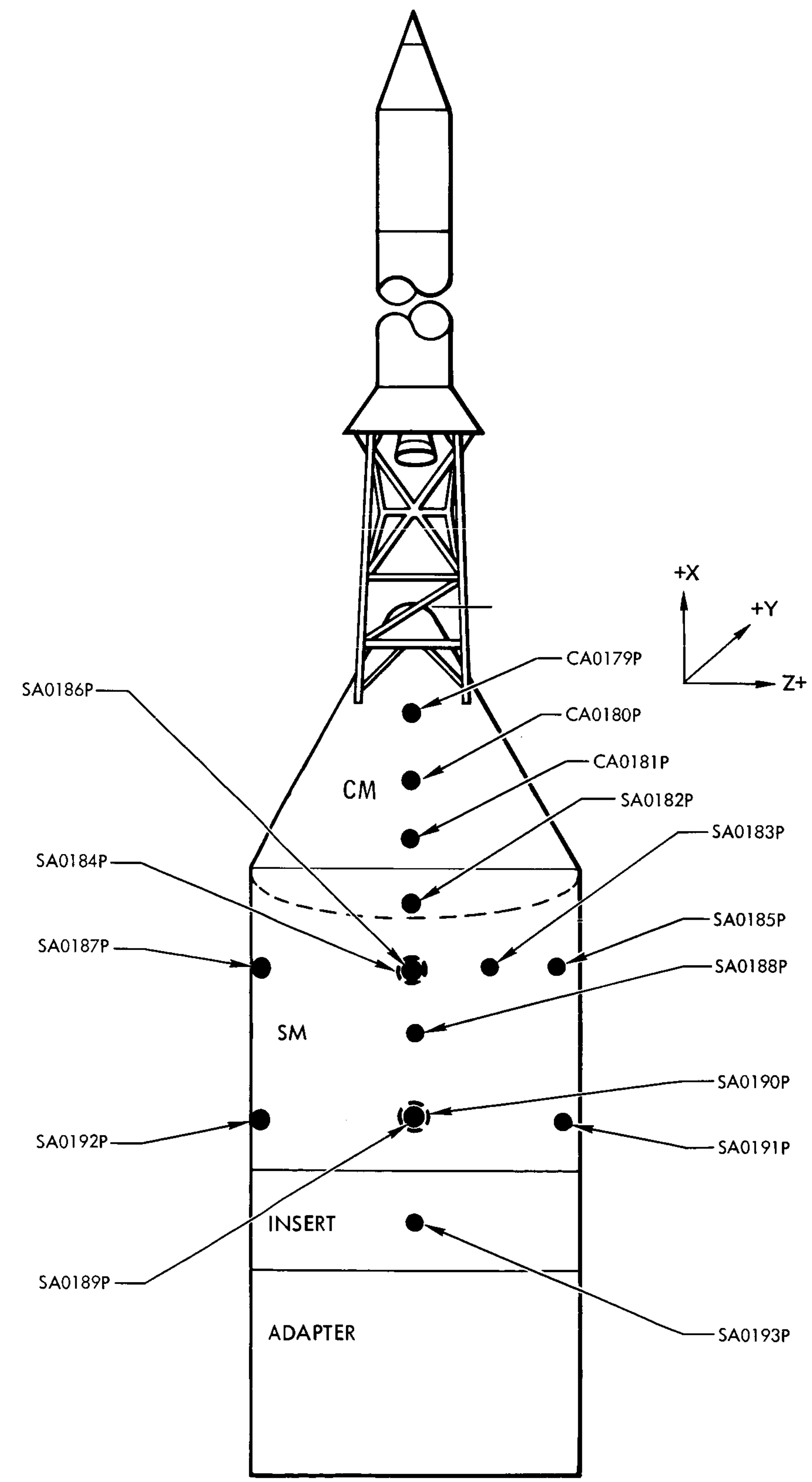
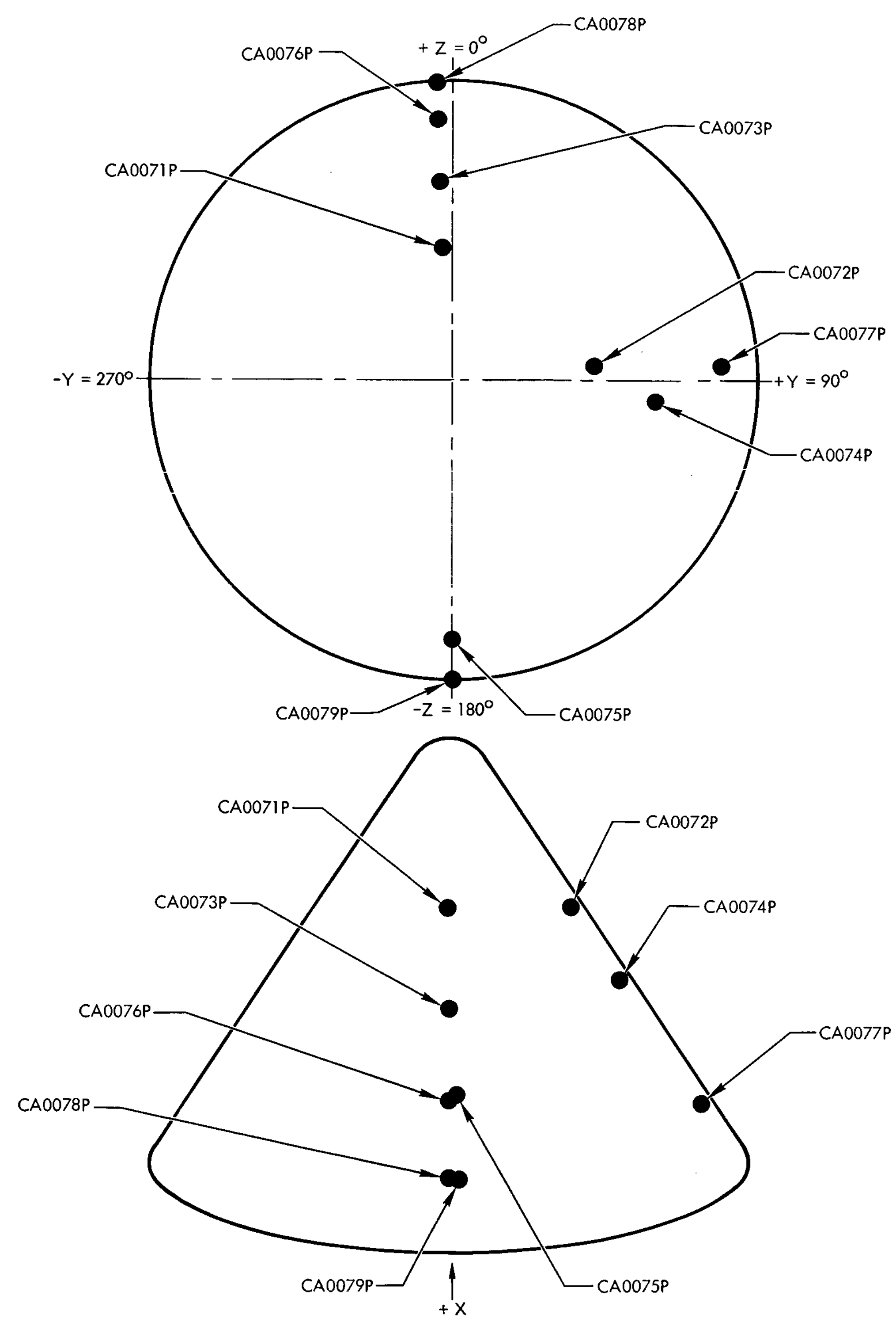



Figure 4-2. R&D Instrumentation Locations (Sheet 3 of 6)



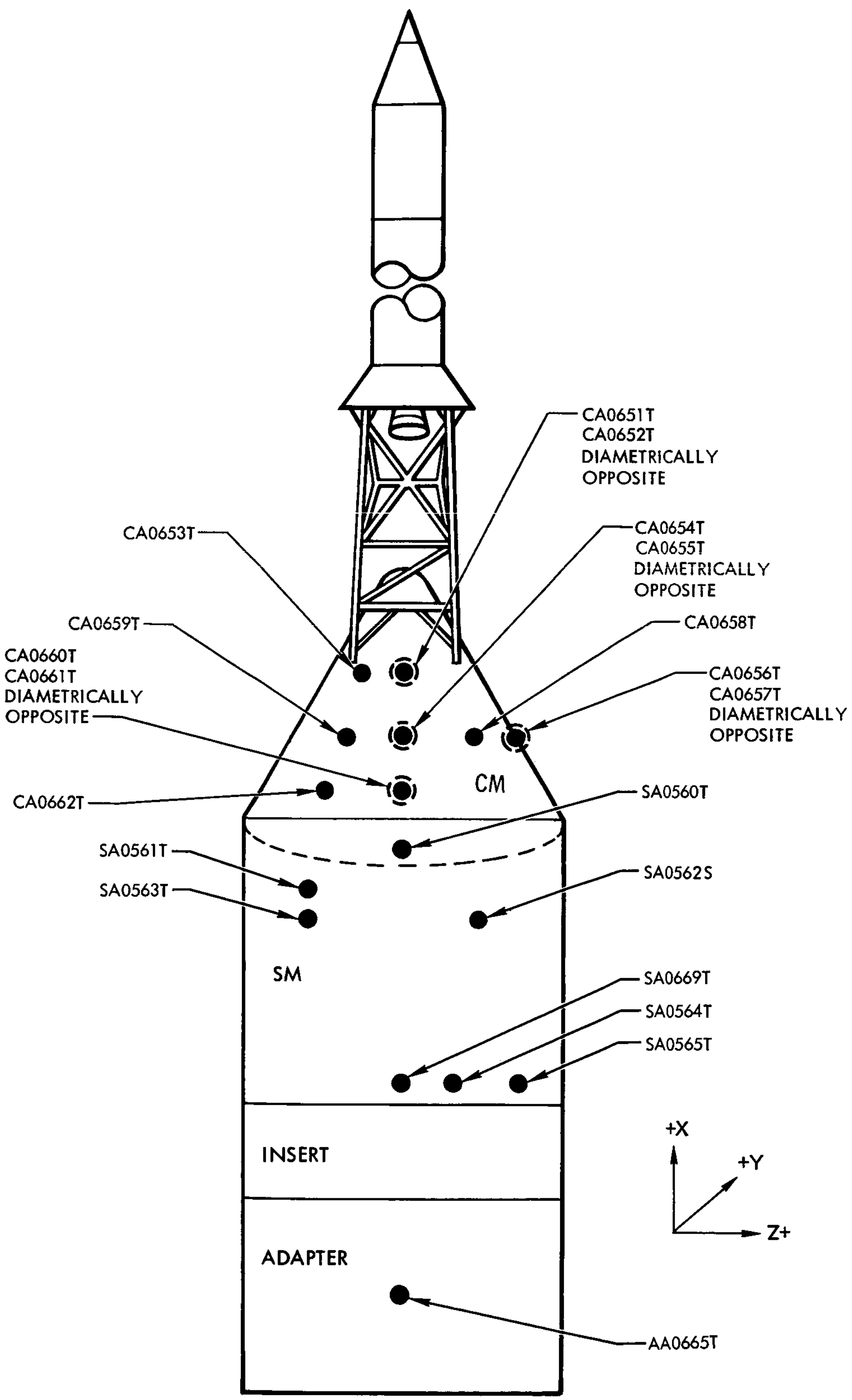

FLUCTUATING PRESSURE TRANSDUCERS (15)



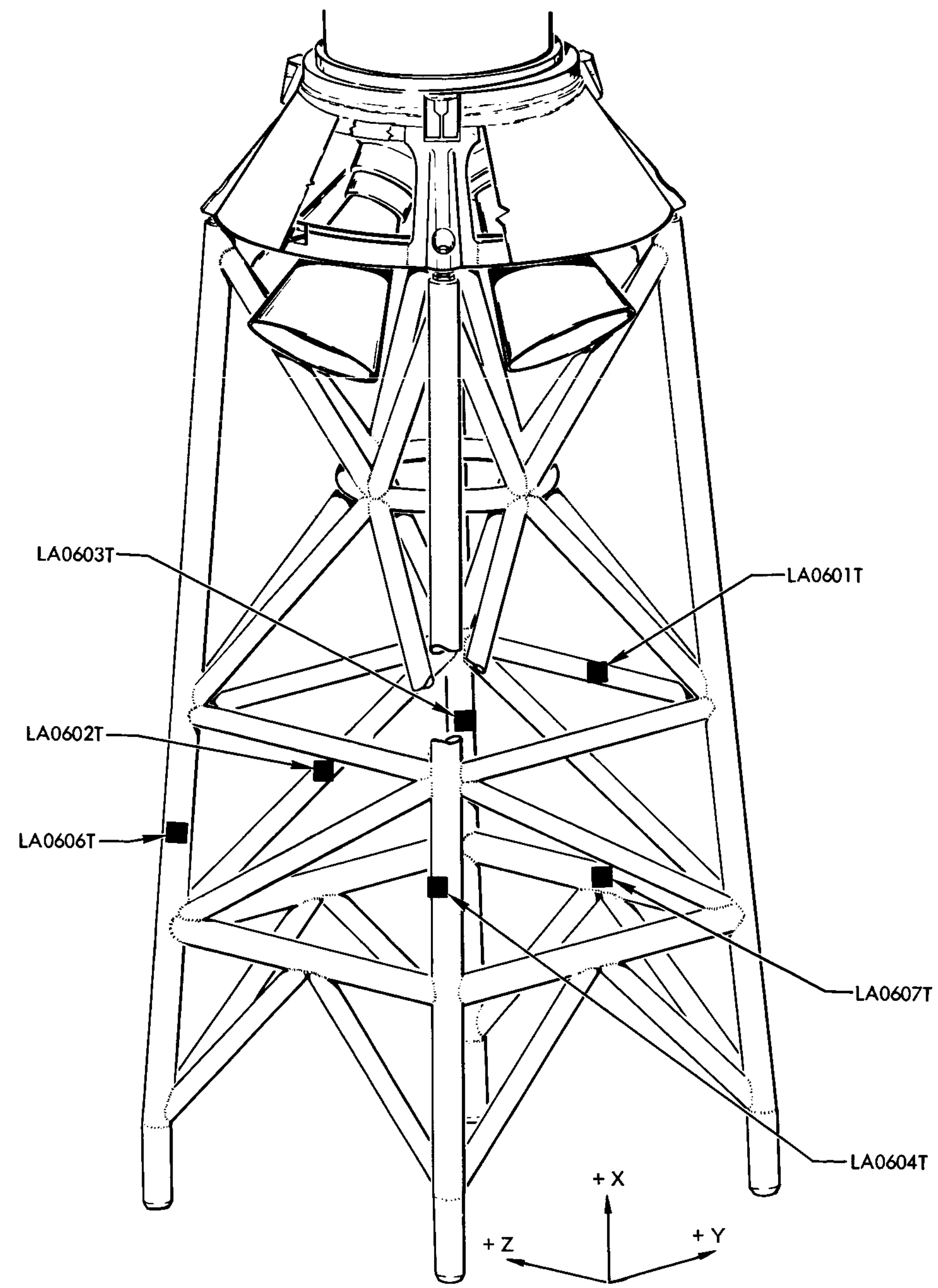

STATIC PRESSURE TRANSDUCERS (9)

SM-2A-371A

Figure 4-2. R&D Instrumentation Locations (Sheet 4 of 6)




CALORIMETER BODY TEMPERATURES (20)




TOWER TEMPERATURES (8)

SM-2A-370B

Figure 4-2. R&D Instrumentation Locations (Sheet 5 of 6)

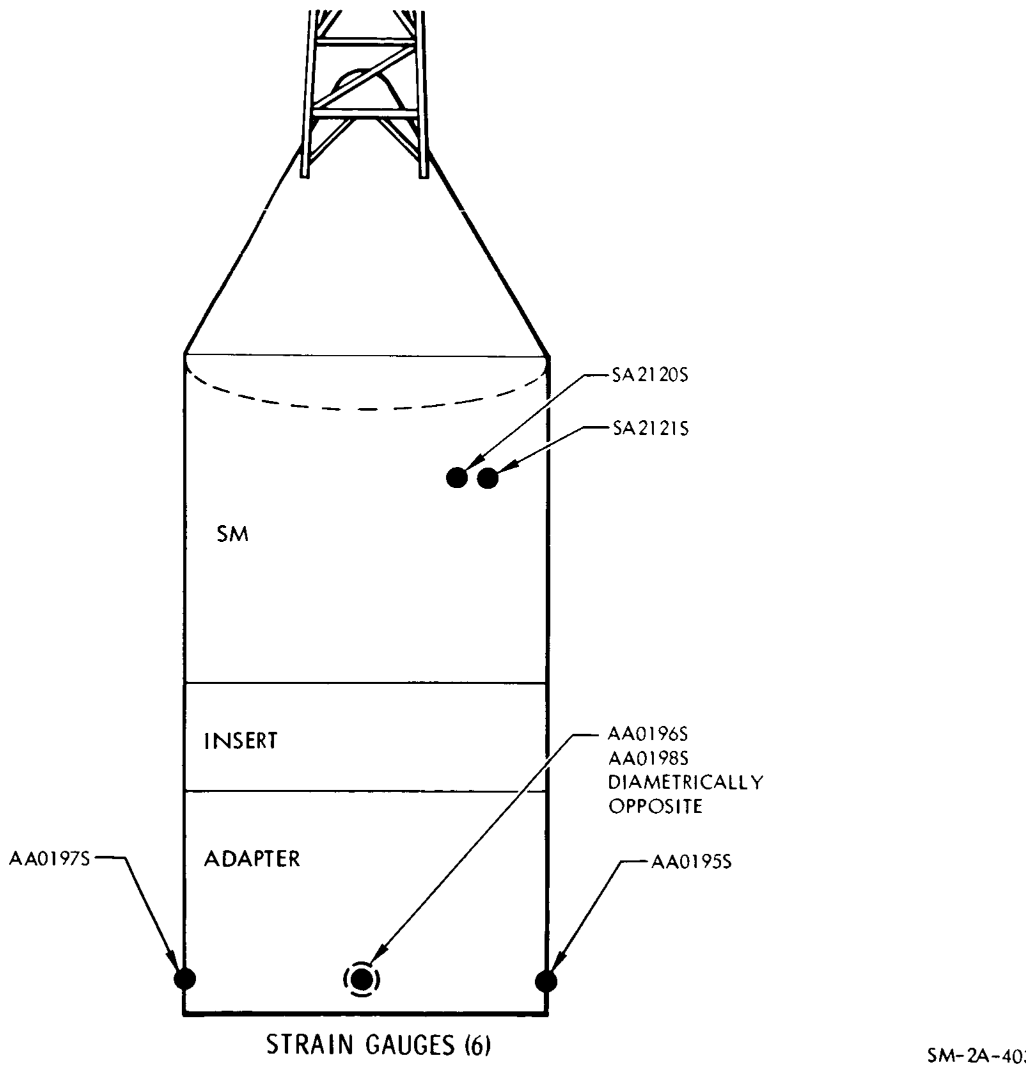



Figure 4-2. R&D Instrumentation Locations (Sheet 6 of 6)

4-14. VIBRATION SENSORS. Spacecraft radial vibrations are monitored by six piezo-electric accelerometers located in the command module (1), service module (3), and adapter (2). The sensor circuitry includes an amplifier which raises the signal to a level compatible with the required signal input of the voltage control oscillator. The two adapter vibration sensors and an acoustical device (microphone) are located on the adapter and service module surface respectively, to determine structural response, and aerodynamic and engine noises during boost and staging phases. These signals are routed through the booster instrument unit.

4-15. STRAIN SENSORS. Four strain gages are mounted on the adapter stringer frame and two on the service module ring frame to determine spacecraft structural integrity under dynamic loads. The circuitry includes an amplifier which raises the signal to a level compatible with the required signal input level of the voltage control oscillators.

4-16. PRESSURE TRANSDUCERS. There are 25 pressure-sensing devices located in the spacecraft. Distribution and purpose of these devices is as follows:

a. One transducer in the command module monitors static cabin pressure.

b. Nine conical-surface pressure sensors are mounted about the command module exterior to determine the aerodynamic effects on the spacecraft verifying stability and loads.

c. Fifteen fluctuating-pressure transducers are located on the spacecraft, three in the command module and twelve in the service module. These measurements help to define boundary-layer noise, confirm environmental predications, and determine sonic-induced vibration response of the service module panels.

4-17. ACCELEROMETERS. Spacecraft acceleration measurements in all three planes are required to determine flight parameters and tower structure flight loads. Two accelerometers are mounted in the nose cone of the launch escape motor. One is assembled to measure acceleration along the Y-axis and the other is assembled to measure acceleration along the Z-axis. Three accelerometers are mounted in the command module to measure acceleration in all three axes; and two accelerometers are mounted in the service module to measure acceleration along the Y- and Z-axes.

4-18. VOLTAGE AND EVENT SIGNALS. Two voltage divider networks monitor the main bus d-c voltage. Voltage divider networks also monitor the voltage levels of the two logic and two pyro buses. This also provides events sequence information as to the time of arming the buses. Other events, which are sensed by relay closure, are jettison motor-ignition command and resultant tower separation, and tower-command module-separation commands from the booster guidance system. The purpose of the voltage measurements is to determine the electrical capability of the electrical power system and the mission sequencer during flight loading conditions. The purpose of the event signals is to demonstrate tower jettison sequencing.

4-19. Sensors are also provided to monitor the sequencer control S-I lift-off signal from the booster instrument unit and to monitor transponder trigger signals.

4-20. TEMPERATURE SENSORS. A temperature sensor is mounted in the interior of both the command module and service module to determine interior temperatures during flight loading conditions. Six thermistors are mounted on the launch escape system tower structure members to determine aerodynamic heating. A thermocouple is mounted on each calorimeter to sense calorimeter body temperature for use in computing heat flow from the data provided by the 20 calorimeters. Telemetry transmitter and r-f amplifier environmental temperatures are monitored by two sensors mounted in each of the telemetry packages.

4-21. CALORIMETERS. Twenty calorimeters are located in the spacecraft to measure heating rates of various areas in order to adequately define aerodynamic heating of the spacecraft. Twelve are located about the command module surface, seven on the service module surface, and one on the adapter surface.

4-22. CURRENT SENSOR. A current sensor is located in the power control box. It monitors the total main power, direct-current flow during system operation to assist in determining the electrical capability and operation of the electrical power system.

4-23. Q-BALL. (See figures 4-3 and 4-4.) Three pressure transducers, with associated electronics and wiring, form the MSFC-furnished Q-ball system. Data provided by the Q-ball includes angle of attack, angle of sideslip, and dynamic ram pressures. The transducers sense airflow direction and pressure through ports in the Q-ball surface. The input voltage is 28 volts dc. This power is converted to 8 kilocycles ac for the transducer bridge and then rectified for amplifier power. The ac transducer signal is amplified and demodulated to provide the dc output. The output of the transducers is proportional to the three different pressures measured. The transducer outputs are routed to the booster instrumentation unit control computer and conditioned for booster telemetry. A heater is provided to prevent icing during prelaunch period and during flight up to Mach 2.

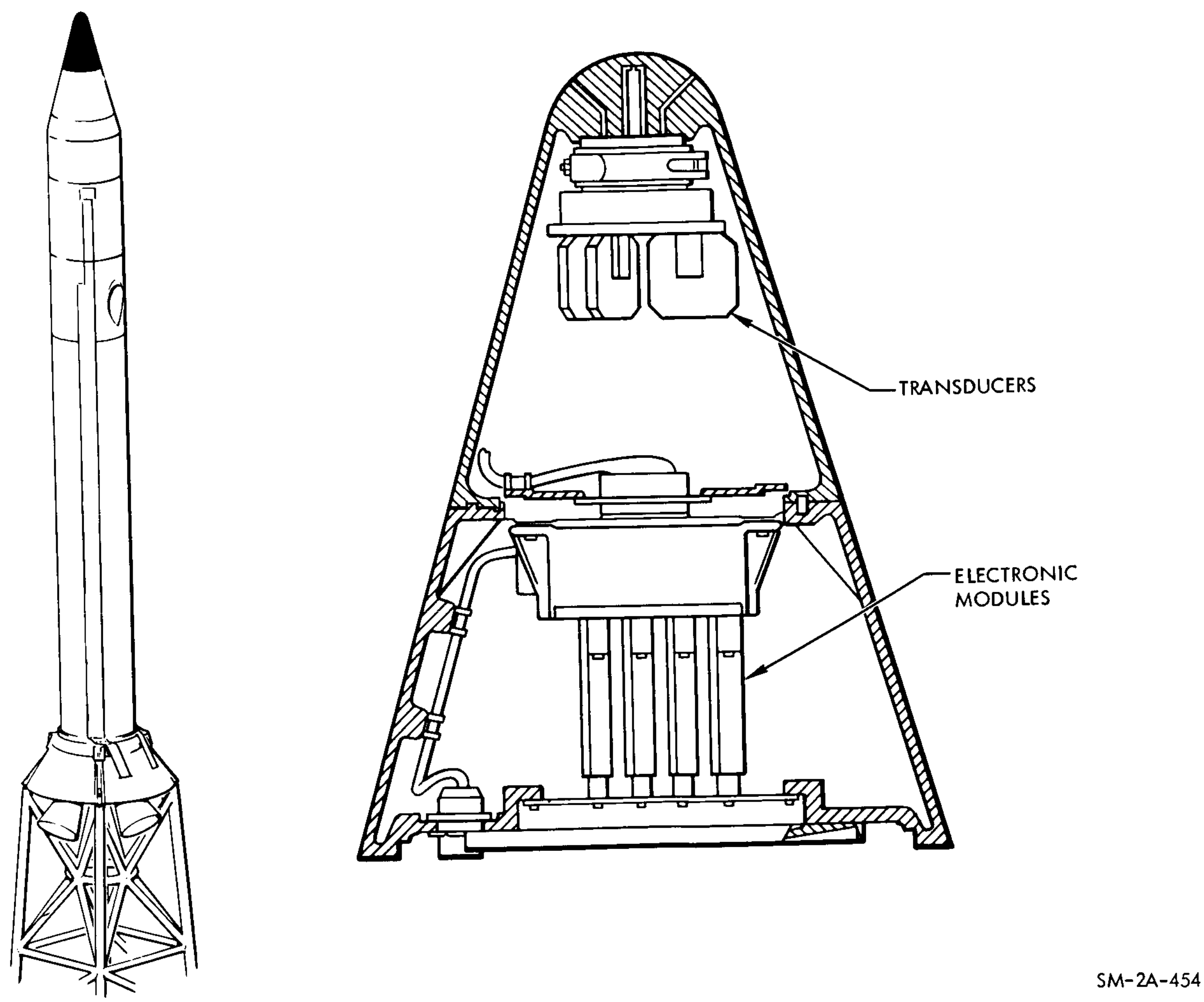



Figure 4-3. Q-Ball

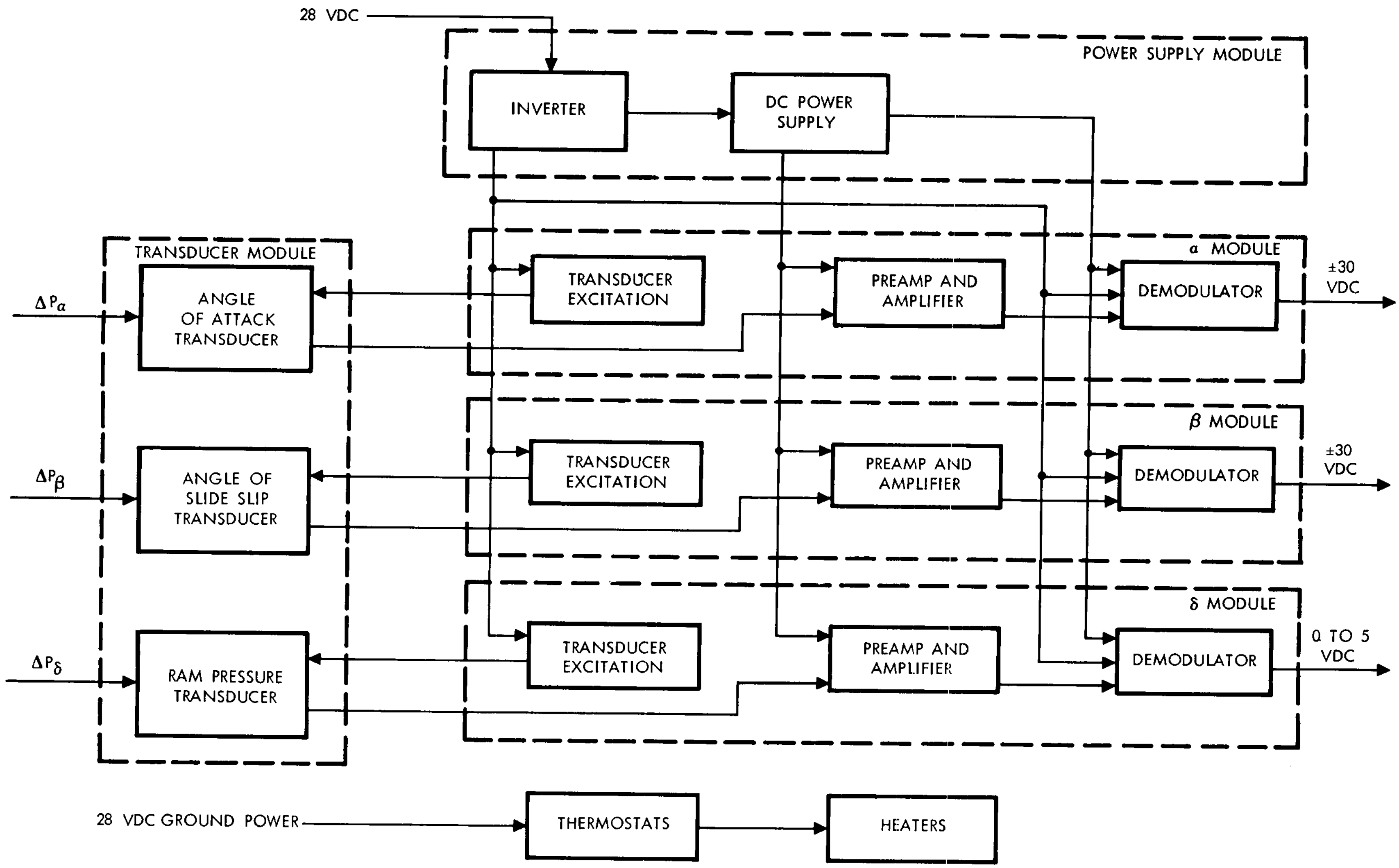



Figure 4-4. Q-Ball Block Diagram

Table 4-1. Measurement List

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| CA0001A | X-Axis Spacecraft Accel High | C | 8 | | -2 | +10 | G | P | 0-30 | cps | XC78, YC0, ZC21 |
| SA0003A | Z-Axis Spacecraft Accel SM | C | 7 | | -0.5 | +0.5 | G | P | 0-20 | cps | XA866, YA0, ZA73 |
| SA0004A | Y-Axis Spacecraft Accel SM | A | 6 | | -0.5 | +0.5 | G | P | 0-20 | cps | XA866, YA0, ZA73 |
| CA0005A | Y-Axis Spacecraft Accel | C | 6 | | -0.5 | +0.5 | G | P | 0-20 | cps | XC78, YC0, ZC21 |
| CA0007A | Z-Axis Spacecraft Accel | B | 6 | | -0.5 | +0.5 | G | P | 0-20 | cps | XC78, YC0, ZC21 |
| LA0011A | Y-Axis Tower Accel | B | 7 | | -2 | +2 | G | P | 0-30 | cps | XL380, YL0, ZL6 |
| LA0012A | Z-Axis Tower Accel | B | 8 | | -2 | +2 | G | P | 0-30 | cps | XL380, YL6, ZL0 |
| CA0021D | CM Radial Vibration 1 | A | 16 | | -50 | +50 | G | P | 20-1000 | C | XC14, YC40.4, ZC37.3 |
| CA0071P | Conical Surface Pressure 1 | A | E | 66 | +0 | +15 | psia | M | 10 | S/S | XC76, 357 Deg |
| CA0072P | Conical Surface Pressure 2 | A | E | 67 | +0 | +15 | psia | M | 10 | S/S | XC76, 87 Deg |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| CA0073P | Conical Surface Pressure 3 | A | E | 68 | +0 | +15 | psia | M | 10 | S/S | XC36, 357 Deg |
| CA0074P | Conical Surface Pressure 4 | A | E | 69 | +0 | +15 | psia | M | 10 | S/S | XC36, 93 Deg |
| CA0075P | Conical Surface Pressure 5 | A | E | 70 | +0 | +15 | psia | M | 10 | S/S | XC29, 180 Deg |
| CA0076P | Conical Surface Pressure 6 | A | E | 71 | +0 | +15 | psia | M | 10 | S/S | XC27, 357 Deg |
| CA0077P | Conical Surface Pressure 7 | A | E | 72 | +0 | +15 | psia | M | 10 | S/S | XC27, 87 Deg |
| CA0078P | Conical Surface Pressure 8 | A | E | 73 | +0 | +15 | psia | M | 10 | S/S | XC20, 357 Deg |
| CA0079P | Conical Surface Pressure 9 | A | E | 74 | +0 | +15 | psia | M | 10 | S/S | XC20, 180 Deg |
| SA0086D | SM Radial Vibration 2 | C | 18 | | -50 | +50 | G | P | 20-1000 | C | XA965.2, YA42.8, ZA-57 |
| SA0087D | SM Radial Vibration 3 | C | 17 | | -50 | +50 | G | P | 20-1000 | C | XA953, YA-53.9, ZA47.7 |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| SA0088D | SM Radial Vibration 4 | B | 17 | | -50 | +50 | G | P | 20-1000 | C | XA940.4, YA68.3, ZA22.8 |
| AA0089D | Adapter Radial Vibration 5 | LV | TM | | -50 | +50 | G | P | 25-2000 | C | XA777.7, YA0, ZA72 |
| AA0090D | Adapter Radial Vibration 6 | LV | TM | | -50 | +50 | G | P | 25-2000 | C | XA777.7, YA-15.5, ZA71 |
| CA0179P | Fluctuating Pressure 1 | B | 18 | | +0 | +15 | psia | M | 1000 | cps | XC100, 357 Deg |
| CA0180P | Fluctuating Pressure 2 | C | 15 | | +0 | +15 | psia | M | 300 | cps | XC70, 357 Deg |
| CA0181P | Fluctuating Pressure 3 | B | 15 | | +0 | +15 | psia | M | 300 | cps | XC40, 357 Deg |
| SA0182P | Fluctuating Pressure 4 | A | 15 | | +0 | +15 | psia | M | 300 | cps | XC12, 357 Deg |
| SA0183P | Fluctuating Pressure 5 | C | 14 | | +0 | +15 | psia | M | 300 | cps | XA974, 43 Deg |
| SA0184P | Fluctuating Pressure 6 | B | 14 | | +0 | +15 | psia | M | 300 | cps | XA974, 357 Deg |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| SA0185P | Fluctuating Pressure 7 | A | 14 | | +0 | +15 | psia | M | 300 | cps | XA974, 87 Deg |
| SA0186P | Fluctuating Pressure 8 | C | 13 | | +0 | +15 | psia | M | 300 | cps | XA974, 177 Deg |
| SA0187P | Fluctuating Pressure 9 | B | 13 | | +0 | +15 | psia | M | 300 | cps | XA974, 267 Deg |
| SA0188P | Fluctuating Pressure 10 | A | 12 | | +0 | +15 | psia | M | 300 | cps | XA930, 357 Deg |
| SA0189P | Fluctuating Pressure 11 | C | 12 | | +0 | +15 | psia | M | 300 | cps | XA881, 357 Deg |
| SA0190P | Fluctuating Pressure 12 | B | 12 | | +0 | +15 | psia | M | 300 | cps | XA881, 177 Deg |
| SA0191P | Fluctuating Pressure 13 | A | 11 | | +0 | +15 | psia | M | 300 | cps | XA881, 87 Deg |
| SA0192P | Fluctuating Pressure 14 | B | 11 | | +0 | +15 | psia | M | 300 | cps | XA881, 267 Deg |
| SA0193P | Fluctuating Pressure 15 | B | 11 | | +0 | +15 | psia | M | 300 | cps | XA833, 357 Deg |
| AA0195S | Strain 1 Adapter | A | 9 | | -1000 | +1000 | UI/IN | M | 100 | cps | XA736, YA76, ZA0 |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| AA0196S | Strain 2 Adapter | A | 10 | | -1000 | +1000 | UI/IN | M | 100 | cps | XA736, YA0, ZA-76 |
| AA0197S | Strain 3 Adapter | B | 10 | | -1000 | +1000 | UI/IN | M | 100 | cps | XA736, YA-76, ZA0 |
| AA0198S | Strain 4 Adapter | C | 10 | | -1000 | +1000 | UI/IN | M | 100 | cps | XA736, YA0, ZA76 |
| SA0550R | Heat Flux (Calorimeter) 17 | A | 13 | 28 | +0 | +5 | B/F/S | | 1.25 | S/S | XS338, 183 Deg |
| SA0551R | Heat Flux (Calorimeter) 18 | A | 13 | 29 | +0 | +5 | B/F/S | | 1.25 | S/S | XS315, 187.2 Deg |
| SA0552R | Heat Flux (Calorimeter) 20 | A | 13 | 31 | +0 | +5 | B/F/S | | 1.25 | S/S | XS305, 177 Deg |
| SA0553R | Heat Flux (Calorimeter) 13 | A | 13 | 24 | +0 | +5 | B/F/S | | 1.25 | S/S | XS305, 187.2 Deg |
| SA0554R | Heat Flux (Calorimeter) 14 | A | 13 | 25 | +0 | +5 | B/F/S | | 1.25 | S/S | XS267, 160 Deg |
| SA0555R | Heat Flux (Calorimeter) 16 | A | 13 | 27 | +0 | +5 | B/F/S | | 1.25 | S/S | XS267, 145 Deg |
| SA0560T | Calorimeter Body Temp 17 | A | 13 | 48 | +0 | +300 | Deg C | | 1.25 | S/S | XS338, 183 Deg |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| AS0561T | Calorimeter Body Temp 18 | A | 13 | 49 | +0 | +300 | Deg C | | 1.25 | S/S | XS315, 187.2 Deg |
| SA0562T | Calorimeter Body Temp 20 | A | 13 | 51 | +0 | +300 | Deg C | | 1.25 | S/S | XS305, 177 Deg |
| SA0563T | Calorimeter Body Temp 13 | A | 13 | 44 | +0 | +300 | Deg C | | 1.25 | S/S | XS305, 187.2 Deg |
| SA0564T | Calorimeter Body Temp 14 | A | 13 | 45 | +0 | +300 | Deg C | | 1.25 | S/S | XS267, 160 Deg |
| SA0565T | Calorimeter Body Temp 16 | A | 13 | 47 | +0 | +300 | Deg C | | 1.25 | S/S | XS267, 145 Deg |
| CA0580R | Heat Flux (Calorimeter) 1 | A | 13 | 12 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC74, 3 Deg |
| CA0581R | Heat Flux (Calorimeter) 2 | A | 13 | 13 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC74, 180 Deg |
| CA0582R | Heat Flux (Calorimeter) 3 | A | 13 | 14 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC74, 319 Deg |
| CA0583R | Heat Flux (Calorimeter) 4 | A | 13 | 15 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC53, 180 Deg |
| CA0584R | Heat Flux (Calorimeter) 5 | A | 13 | 16 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC52, 3 Deg |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| CA0585R | Heat Flux (Calorimeter) 6 | A | 13 | 17 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC52, 80 Deg |
| CA0586R | Heat Flux (Calorimeter) 7 | A | 13 | 18 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC52, 85 Deg |
| CA0587R | Heat Flux (Calorimeter) 8 | A | 13 | 19 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC52, 95 Deg |
| CA0588R | Heat Flux (Calorimeter) 9 | A | 13 | 20 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC52, 319 Deg |
| CA0589R | Heat Flux (Calorimeter) 10 | A | 13 | 21 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC42.65 Deg |
| CA0590R | Heat Flux (Calorimeter) 11 | A | 13 | 22 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC27, 180 Deg |
| CA0591R | Heat Flux (Calorimeter) 12 | A | 13 | 23 | +0 | +25 | B/F/S | M | 1.25 | S/S | XC27, 319 Deg |
| AA0594R | Heat Flux (Calorimeter) 19 | A | 13 | 30 | +0 | +5 | B/F/S | M | 1.25 | S/S | XA770, 183 Deg |
| SA0598R | Heat Flux (Calorimeter) 15 | A | 13 | 26 | +0 | +5 | B/F/S | M | 1.25 | S/S | XA933, 183 Deg |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| LA0601T | Tower Temperature 2 | A | 13 | 53 | +0 | +150 | Deg C | M | 1.25 | S/S | XL61, YL22, ZL0 |
| LA0602T | Tower Temperature 3 | A | 13 | 54 | +0 | +150 | Deg C | M | 1.25 | S/S | SL47, YL0, ZL23 |
| LA0603T | Tower Temperature 4 | A | 13 | 55 | +0 | +150 | Deg C | M | 1.25 | S/S | XL47, YL24, ZL23 |
| LA0604T | Tower Temperature 5 | A | 13 | 56 | +0 | +150 | Deg C | M | 1.25 | S/S | XL47, YL-24, ZL-23 |
| LA0606T | Tower Temperature 7 | A | 13 | 58 | +0 | +150 | Deg C | M | 1.25 | S/S | XL47, YL-24, ZL23 |
| LA0607T | Tower Temperature 8 | A | 13 | 59 | +0 | +150 | Deg C | M | 1.25 | S/S | XL36, YL24, ZL0 |
| CA0610T | CM Interior Temp | A | 13 | 4 | +0 | +150 | Deg C | S | 1.25 | S/S | CM Interior |
| CA0611P | CM Interior Press | A | E | 88 | +0 | +15 | Psia | S | 10 | S/S | CM Interior |
| SA0612T | SM Interior Temp | A | 13 | 5 | +0 | +150 | Deg C | S | 1.25 | S/S | SM Interior |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| CA0651T | Calorimeter Body Temp 1 | A | 13 | 32 | +0 | +300 | Deg C | S | 1.25 | S/S | XC74, 3 Deg |
| CA0652T | Calorimeter Body Temp 2 | A | 13 | 33 | +0 | +300 | Deg C | S | 1.25 | S/S | XC74, 180 Deg |
| CA0653T | Calorimeter Body Temp 3 | A | 13 | 34 | +0 | +300 | Deg C | S | 1.25 | S/S | XC74, 319 Deg |
| CA0654T | Calorimeter Body Temp 4 | A | 13 | 35 | +0 | +300 | Deg C | S | 1.25 | S/S | XC53, 180 Deg |
| CA0655T | Calorimeter Body Temp 5 | A | 13 | 36 | +0 | +300 | Deg C | S | 1.25 | S/S | XC52, 3 Deg |
| CA0656T | Calorimeter Body Temp 6 | A | 13 | 37 | +0 | +300 | Deg C | S | 1.25 | S/S | XC52, 80 Deg |
| CA0657T | Calorimeter Body Temp 7 | A | 13 | 38 | +0 | +300 | Deg C | S | 1.25 | S/S | XC52, 85 Deg |
| CA0658T | Calorimeter Body Temp 8 | A | 13 | 39 | +0 | +300 | Deg C | S | 1.25 | S/S | XC52, 95 Deg |
| CA0659T | Calorimeter Body Temp 9 | A | 13 | 40 | +0 | +300 | Deg C | S | 1.25 | S/S | XC52, 319 Deg |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STRUCTURES | | | | | | | | | | | |
| CA0660T | Calorimeter Body Temp 10 | A | 13 | 41 | +0 | +300 | Deg C | S | 1.25 | S/S | XC27, 3 Deg |
| CA0661T | Calorimeter Body Temp 11 | A | 13 | 42 | +0 | +300 | Deg C | S | 1.25 | S/S | XC42.65,180 Deg |
| CA0662T | Calorimeter Body Temp 12 | A | 13 | 43 | +0 | +300 | Deg C | S | 1.25 | S/S | XC27, 319 Deg |
| AA0665T | Calorimeter Body Temp 19 | A | 13 | 50 | +0 | +300 | Deg C | S | 1.25 | S/S | XA770, 183 Deg |
| SA0669T | Calorimeter Body Temp 15 | A | 13 | 46 | +0 | +300 | Deg C | S | 1.25 | S/S | XA933, 183 Deg |
| SA2120S | Strain 1 Service Module | B | 16 | | -4000 | +4000 | UI/IN | M | 250 | cps | XA940.4, 62.25 Deg |
| SA2121S | Strain 2 Service Module | C | 16 | | -4000 | +4000 | UI/IN | M | 250 | cps | XA940.4, 77.25 Deg |
| SA2760Y | Service Module Acoustic | LV | TM | | +150 | +170 | db | S | 25-3000 | C | XS339, 0 Deg |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ELECTRICAL SYSTEM | | | | | | | | | | |
| CC0001V | DC Voltage Main Bus A | A | E | 24 | +22 | +32 | vdc | P | 10 | S/S | Pwr Control Box |
| CC0002V | DC Voltage Main Bus B | A | E | 25 | +22 | +32 | vdc | P | 10 | S/S | Pwr Control Box |
| CC0003V | DC Voltage Logic Bus A | A | E | 22 | +0 | +36 | vdc | P | 10 | S/S | LES Sequencer |
| CC0004V | DC Voltage Logic Bus B | A | E | 23 | +0 | +36 | vdc | P | 10 | S/S | LES Sequencer |
| CC0005C | Total DC Current | A | E | 26 | +0 | +50 | amps | P | 10 | S/S | Pwr Control Box |
| | LAUNCH ESCAPE SYSTEM | | | | | | | | | | |
| BD0001X | S-I Lift Off Signal | A-9 | A-10 | | | | Step | M | 100 | cps | Sig Cond Box |
| LD0033X | Twr Jett and Sep Relay Close A | A | E | 29 | | | Step | P | 10 | S/S | Twr LES Sequencer |
| LD0034X | Twr Jett and Sep Relay Close B | A | E | 29 | | | Step | P | 10 | S/S | Twr LES Sequencer |
| CD0039V | S-I Sep Signal A | A | E | 37 | +0 | +36 | vdc | P | 10 | S/S | LES Sequencer |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LAUNCH ESCAPE SYSTEM | | | | | | | | | | | |
| CD0040V | S-I Sep Signal B | A | E | 38 | +0 | +36 | vdc | P | 10 | S/S | LES Sequencer |
| CD0185V | DC Voltage Twr Pyro Bus A | A | E | 28 | +0 | +36 | vdc | P | 10 | S/S | LES Sequencer |
| CD0186V | DC Voltage Twr Pyro Bus B | A | E | 35 | +0 | +36 | vdc | P | 10 | S/S | LES Sequencer |
| COMMUNICATIONS AND INSTRUMENTATION SYSTEM | | | | | | | | | | | |
| CT0002V | Transponder A Trigger | A | E | 57 | +0 | +5 | vdc | S | 10 | S/S | Transponder A |
| CT0003V | Transponder B Trigger | A | E | 58 | +0 | +5 | vdc | S | 10 | S/S | Transponder B |
| CT0007X | R and Z Calibration Monitor | A | E | 59 | | | Step | P | 10 | S/S | Sig Cond Box |
| CT0201T | TM RF XMTR A Temp | A | 13 | 6 | +0 | +150 | Deg C | S | 1.25 | S/S | TM RF XMTR A |
| CT0202T | TM RF AMP A Temp | A | 13 | 7 | +0 | +150 | Deg C | S | 1.25 | S/S | TM RF AMP A |

Table 4-1. Measurement List (Cont)

| Meas. ID | Measurement Description | Channel L K | Channel SC No. | Channel Com Seg | Data Range Low | Data Range High | Data Range Unit | PR | Response Rate | Response Unit | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| COMMUNICATIONS AND INSTRUMENTATION SYSTEM | | | | | | | | | | | |
| CT0203T | TM RF XMTR B Temp | A | 13 | 8 | +0 | +150 | Deg C | S | 1.25 | S/S | TM RF XMTR B |
| CT0204T | TM RF AMP B Temp | A | 13 | 9 | +0 | +150 | Deg C | S | 1.25 | S/S | TM RF AMP B |
| CT0205T | TM RF XMTR C Temp | A | 13 | 10 | +0 | +150 | Deg C | S | 1.25 | S/S | TM RF XMTR C |
| CT0207T | TM RF AMP C Temp | A | 13 | 11 | +0 | +150 | Deg C | S | 1.25 | S/S | TM RF AMP C |

# SECTION V

# EQUIPMENT COOLING SYSTEM

## 5-1. PURPOSE.

5-2. The equipment cooling system is a specially designed water-glycol system which provides a coolant for five coldplates (three telemetry r-f packages and two C-band transponders). It also provides a continuous flow of air in the crew compartment for compartment cooling during ground operation and during the initial boost phase of the flight.

## 5-3. SYSTEM DESCRIPTION. (See figure 5-1.)

5-4. The complete cooling system for boilerplate 13 is located in the command module. The major components of the system are the supply tank, coolant pump, coldplates, heat exchanger with fan, accumulator, thermal control valve, and temperature and pressure transducers.

## 5-5. PRINCIPLES OF OPERATION. (See figure 5-2.)

5-6. OPERATION DURING MISSION. Coolant flow through the equipment cooling system is maintained by the pump assembly. The 250-pound capacity water-glycol tank operates in a standby condition to supply low-temperature coolant, when required, through the thermal control valve into the instrumentation cooling system. The thermal control valve is an automatic bypass valve which regulates the flow of coolant out of the tank into the closed cooling circuit. The thermal control valve is set to control the system temperature at 40±5°F for any inlet temperature encountered during the mission. The coolant continues from the thermal control valve to the series-connected coldplates of modulation packages A, B, and C, and of C-band transponders 1 and 2. The heat exchanger receives the fluid from the coldplates and removes the ambient air heat load given off by the R&D instruments. Ambient air is circulated by the fan around the coiled tubing of the heat exchanger for crew compartment cooling.

5-6A. Electrical power for equipment cooling system operation is supplied by the main batteries (figure 5-3). Power from the batteries is routed through relay contacts to bus B in the power control box. Power from bus B is routed through relay contacts and fuses to a three-phase inverter and two series connected baro-switches. The three-phase inverter supplies power to operate the three-phase water-glycol pump motor. Power through the two baroswitches operates the heat exchanger control and the single-phase inverter which powers the fan motor. At

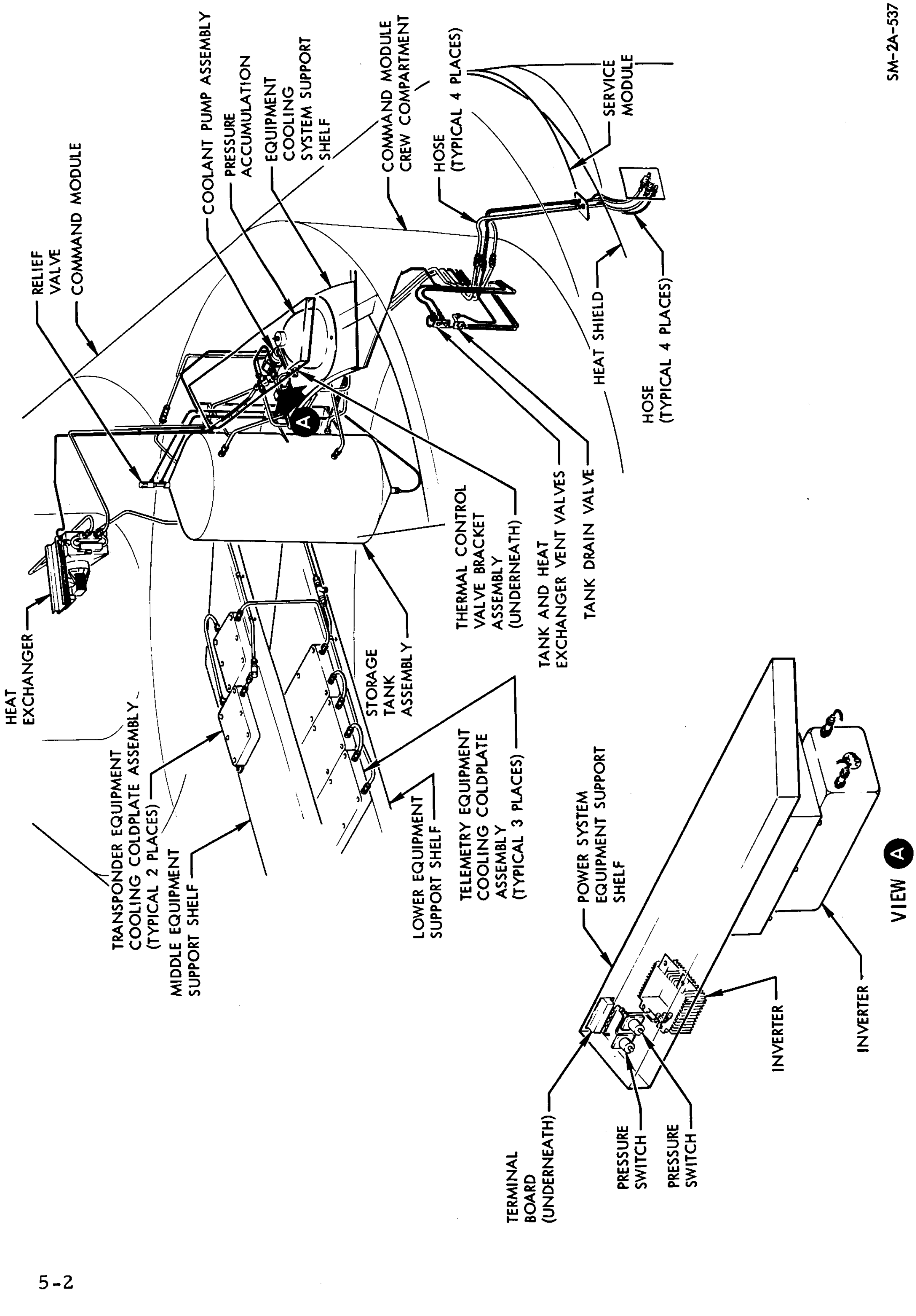



Figure 5-1. Equipment Cooling System

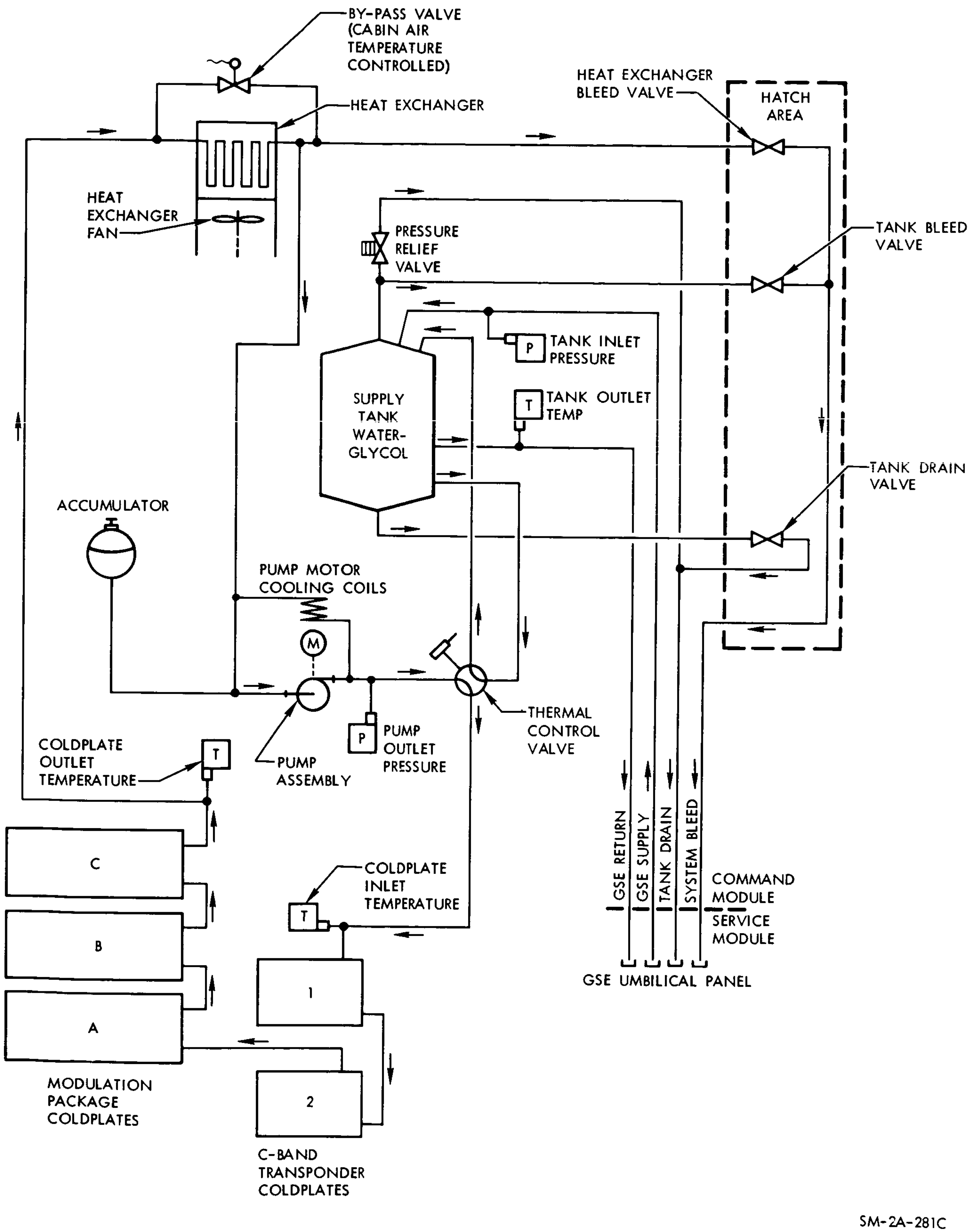



Figure 5-2. Equipment Cooling System Schematic Diagram

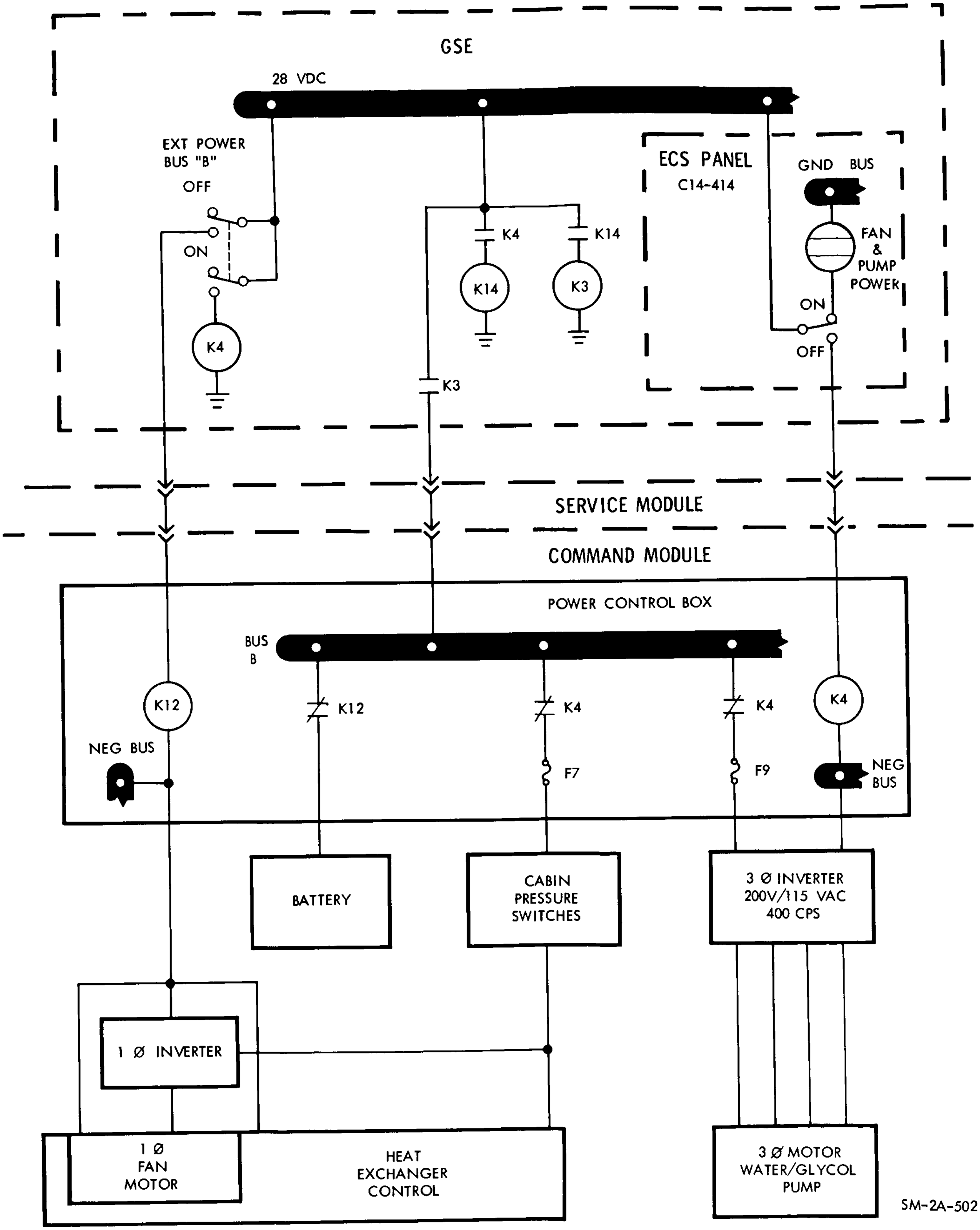



Figure 5-3. Equipment Cooling System Electrical Schematic (Sheet 1 of 2)

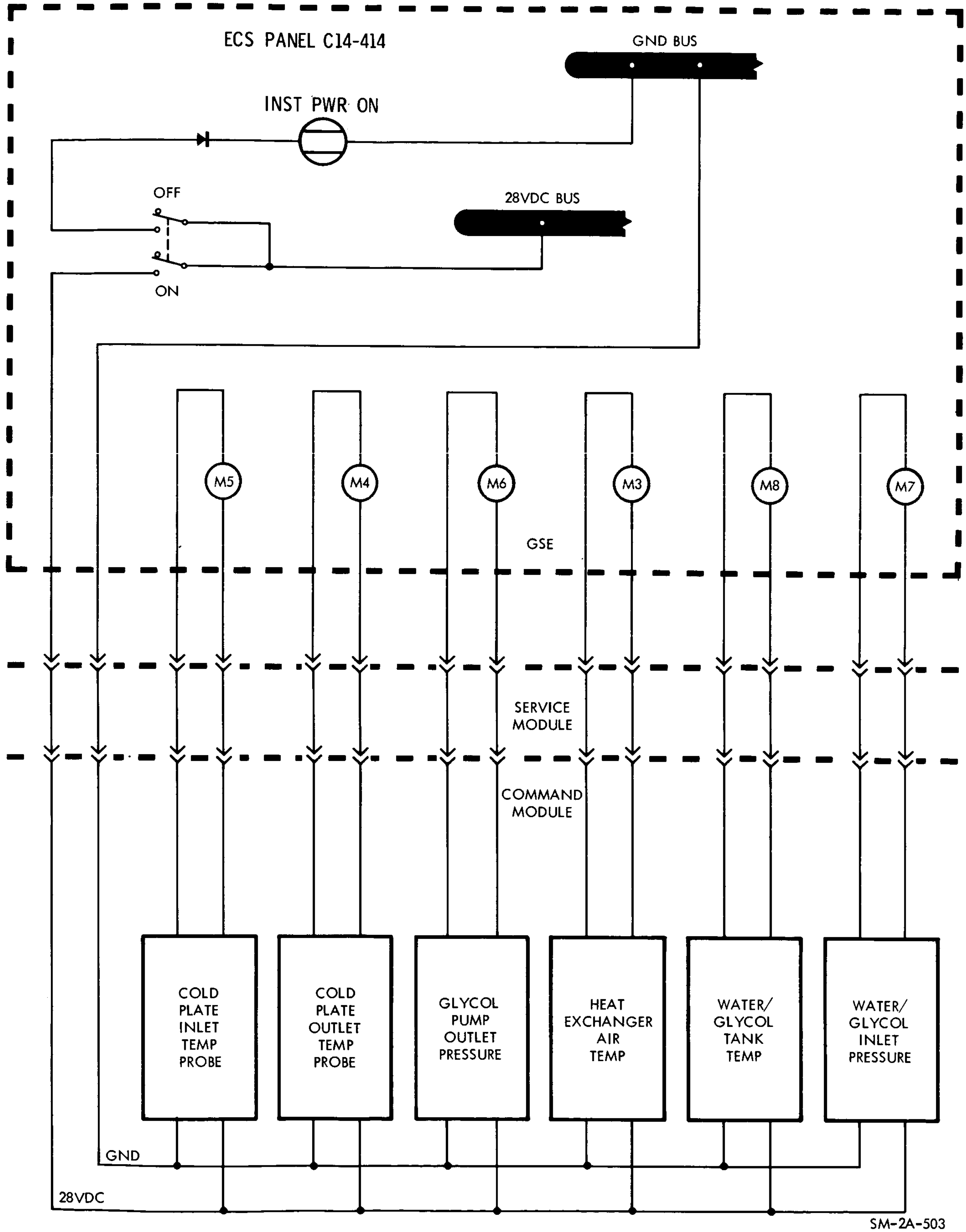



Figure 5-3. Equipment Cooling System Electrical Schematic (Sheet 2 of 2)

a command module cabin pressure of 5 psi, the two baroswitches open, shutting down operation of the heat exchanger control, single-phase inverter, and fan motor. (See figure 5-1 for inverter location.)

5-7. OPERATION ON THE LAUNCH PAD. Ground support equipment furnishes water-glycol at 20°F to spacecraft via umbilical disconnect. The coolant continually flows into the tank, exciting the fluid in the tank, and back out the outlet line for return to the GSE. The supply line and return line to the ground support equipment is disconnected automatically by an umbilical disconnect. Pressure transducers are installed at the pump outlet and glycol tank inlet for checking system pressure. Temperature sensors are installed in the lines at the inlet side of the modulation package coldplates, at the inlet side of the heat exchanger, at the outlet side of the glycol tank, and at the heat exchanger solenoid. This instrumentation is provided for ground monitoring only. (See figures 5-1 and 5-2.)

# SECTION VI

# ELECTRICAL POWER SYSTEM

## 6-1. PURPOSE.

6-2. The electrical power system supplies power to the environmental control system and to all operational units of the communications and instrumentation system for switching and distribution of events that occur during a mission. It also provides switching arrangement for event distribution to the signal conditioning unit and operating and monitoring power for launch escape system functions.

## 6-3. SYSTEM EQUIPMENT.

6-4. The electrical power system consists of six multi-cell, silver, zinc-oxide batteries, a power control box, a junction box, and associated wire harnesses. These units are located on the equipment racks of the command module. Table 6-1 contains the physical characteristics of the batteries.

Table 6-1. Battery Physical Characteristics

| | |
|---|---|
| Main Batteries: (Instrumentation) | |
| Height | 9.50 inches |
| Width | 6.36 inches |
| Length | 9.05 inches |
| Weight | 52 pounds |
| Nominal voltage | 28 volts |
| Capacity | 120 ampere hours |
| Electrolyte | Potassium hydroxide |
| Pyro and Logic Batteries: | |
| Height | 3.52 inches |
| Width | 4.69 inches |
| Length | 7.00 inches |
| Weight | 7.6 pounds |
| Nominal voltage | 28 volts |
| Capacity | 5 ampere hours |
| Electrolyte | Potassium hydroxide |

6-5. PRINCIPLES OF OPERATION. (See figure 6-1.)

6-6. The main batteries (NASA-furnished) provide the electrical power required to energize the instrumentation devices and telemetry equipment, such as sensors and amplifiers. The main batteries supply power to bus A and B of the power control box through normally closed contacts of the internal A and B power control relays. These relays can only be energized by GSE action. The power control relays remain open when power is being supplied by GSE to preserve the battery power prior to umbilical disconnect. Power transfer is accomplished manually. When power from GSE is discontinued, the power control relays close and system power is supplied by the on-board batteries.

6-7. The pyro batteries provide electrical power to energize the tower separation system and the tower jettison motor initiators. Redundant circuits provide the high reliability required to assure a successful mission.

6-8. The logic batteries provide electrical power to energize control circuitry of the mission and tower sequencers. Redundant circuits provide the high reliability required to assure a successful mission.

6-9. POWER CONSUMPTION.

6-10. Optimum power requirements by system are as follows:

a. Equipment cooling system — 396 watts (mission)

b. Communications and instrumentation system — 924 watts (mission)

c. Launch escape system:

1. Tower jettison motor squibs — 18 watts (for 20 milliseconds)

2. Tower leg separation squibs — 72 watts (for 20 milliseconds)

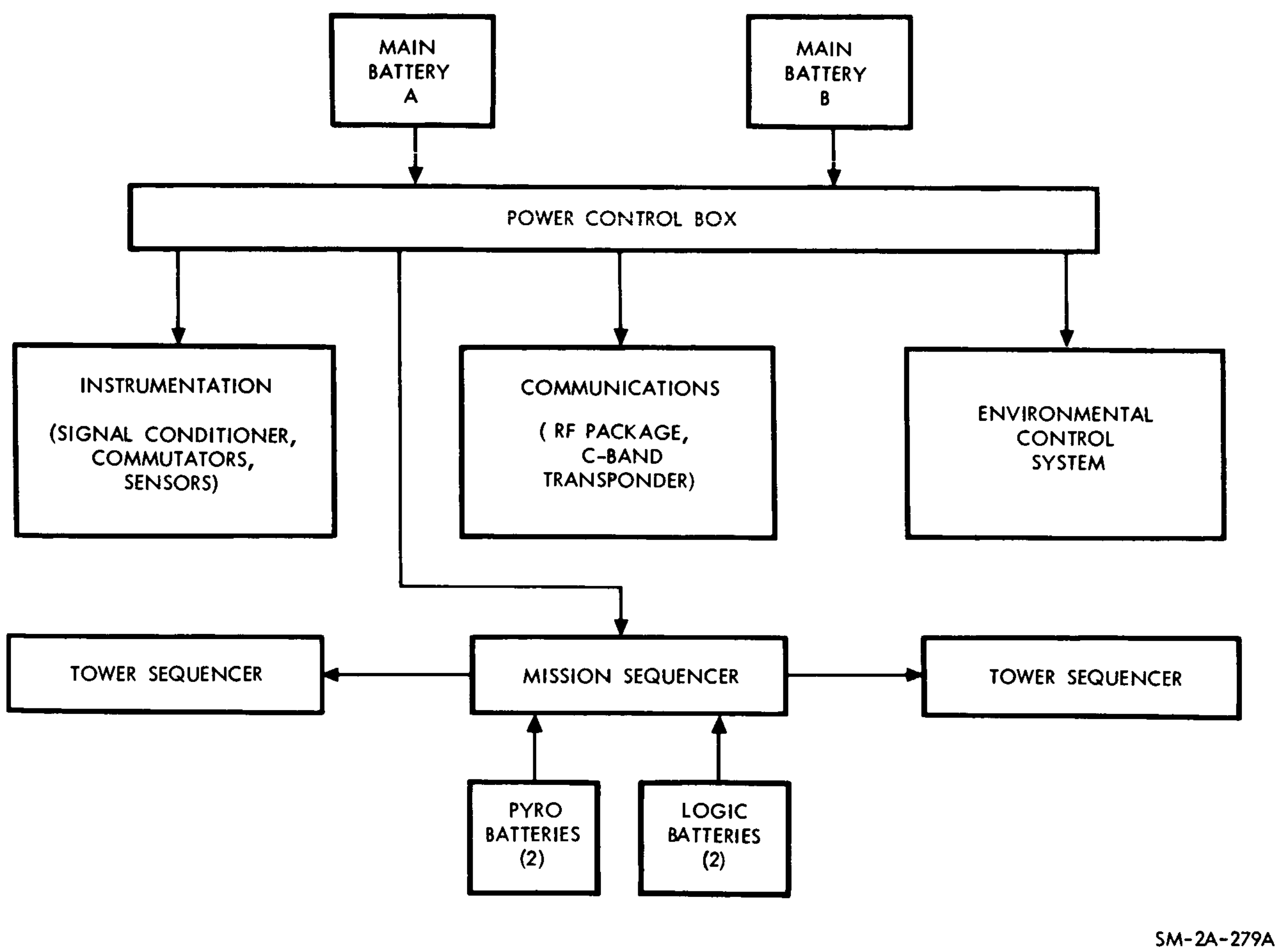



Figure 6-1. Electrical Power System Block Diagram

# SECTION VII

# DOCUMENTATION AND SUPPORTING EQUIPMENT

## 7-1. PURPOSE.

7-2. This section contains a list of documentation and lists support equipment for boilerplate 13.

## 7-3. DOCUMENTATION.

7-4. Table 7-1 is a list of documents containing supplementary information for boilerplate 13.

Table 7-1. Boilerplate 13 Supplementary Documents

| Document No. | Title | Contents |
|---|---|---|
| SM1A-1 | Support Manual Index | This manual contains a complete listing of Apollo support manuals. |
| SM2A-02 | Spacecraft Familiarization Handbook | Description of spacecraft with all systems in overall terms. |
| SM2A-05-BP13 | Transportation and Handling Procedures | Instructions for handling, packaging, packing shipping, transporting, and storing the Apollo spacecraft for boilerplate 13 and its associated ground support equipment. |
| SM3A-201 | Transportation and Handling Equipment Maintenance Data Sheets | Maintenance procedures for transportation and handling equipment. |
| SM2A-01-1-BP13 | Operation and Test Procedures for Assembly, Erection, System/Integrated Systems C/O (Downey Facility) | Detailed instructions for assembly, installation and checkout of boilerplate 13 at NAA/SID, Downey, California only. |

Table 7-1. Boilerplate 13 Supplementary Documents (Cont)

| Document No. | Title | Contents |
|---|---|---|
| SM3A-202 | Auxiliary Checkout and Servicing Equipment Maintenance Data Sheets | Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment. |
| SM3A-204 | Signal Conditioner Console, Model C14-135, Part No. G16-552500-101 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-205 | Radar Transponder and Recovery Beacon Checkout Unit, Model C14-112, Part No. G16-852900 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-208 | Data Distribution and Recording Console, Model C14-420, Part No. G16-850500-101 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-213 | Antenna Checkout Group, Model C14-032, Part No. G16-850400-101 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-221 | Ground Cooling Cart, Model A14-011, Part No. J67000 (Model F-127) | Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment. |
| SM3A-222 | Launch Escape Tower Substitute Unit, Model A14-001, Part No. G16-820301-201 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-226 | Pyrotechnics Bench Maintenance Equipment, Model C14-051, Part No. G16-852700-101 | Physical and functional description and maintenance procedures consisting of functional tests and repairs. |

Table 7-1. Boilerplate 13 Supplementary Documents (Cont)

| Document No. | Title | Contents |
|---|---|---|
| SM3A-227 | Launch Escape Sequencer Bench Maintenance Equipment, Model No. C14-029, Part No. G16-853400-201 | Physical and functional description of test, trouble analysis, repair, servicing, packaging, and diagrams as related to boilerplate 13 configuration. |
| SM3A-228 | Launch Vehicle Subsitute Unit, Model A14-021, Part No. G16-821300 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-229 | Optical Alignment Set, Model A14-028, Part No. G17-824010 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-235 | Launch Control Group, Model C14-414, Part No. G16-853950-101 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-244 | Pyrotechnics Initiators Substitute Set, Model A14-003, Part No. G16-820500-201 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM3A-263 | Water-Glycol Cooling Unit, Model S14-052, Part No. G16-848020 | Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment. |
| SM3A-272 | MSFC Patch and Logic Distribution Sub Unit, Model A14-075, Part No. G16-853060 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |

Table 7-1. Boilerplate 13 Supplementary Documents (Cont)

| Document No. | Title | Contents |
|---|---|---|
| SM3A-273 | Umbilical Junction Box, Model C14-192, Part No. G16-852850 | Physical and functional description and maintenance procedures consisting of functional tests and repair. |
| SM4A-200-BP13 | Maintenance Procedures BP13 | Maintenance procedures, consisting of testing, trouble analysis, repair, removal and installation, and calibration and adjustment as related to boilerplate 13 configuration. |

7-5. SUPPORTING EQUIPMENT.

7-6. The supporting equipment for boilerplate 13 is ground support equipment GSE listed in table 7-2. All listed GSE has been shop-released and approved by NASA.

Table 7-2. Ground Support Equipment

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| A14-001 | Launch escape tower substitute unit | G16-820301-201 | Provides electrical interface normally presented by LES to command module. |
| A14-003 | Pyrotechnic initiators substitute set | G16-820500-201 | Substitutes for the pyrotechnic initiators during systems check-out. |
| A14-009 | Spacecraft adapter cover | G18-828001 | A lightweight, synthetic, impregnated, fabric cover to protect adapter from sand, dust, rain, and salt spray. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| A14-010 | Command module cover | G16-828001 | A lightweight, synthetic, impregnated, fabric cover, fitted to conform to the shape of command module and used for protection against sand, dust, rain, and salt spray. |
| A14-011 | Ground cooling cart | ME-362-0002-0001 | Used to filter, cool, dehumidify, or heat ambient air to a suitable level for introduction into interior of command module. |
| A14-020 | Service module cover | G17-828003 | A lightweight, synthetic, impregnated, fabric cover, fitted to conform to the shape of service module. Used to protect service module from sand, rain, and salt spray during handling, transportation, and storage. |
| A14-021 | Launch vehicle substitute unit C-1 | G16-821300 | Substitute for signals generated by the Saturn launch vehicle to boilerplate. Also provides power to Q-ball and monitors signals that may be returned from Q-ball electronics. |
| A14-022 | Launch escape system cover | G15-828004-101 | A lightweight, impregnated, fabric cover, fitted to conform to shape of LES wherever possible. The cover consists of three sections which fasten together with zippers to form a weatherproof shield. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| A14-024 | Disconnect set, umbilical, fluid, and electrical | G16-828010-101 | Interconnects GSE fluid and electrical lines with spacecraft umbilical panel. Provides a method of automatically disengaging fluid and electrical lines. |
| A14-026 | Cap and plug set | G14-828012-301 | Consists of covers, caps, and plugs for all electrical, hydraulic, and mechanical disconnects; duct, pipe, interface openings, and areas to be protected from shipping and handling damage. |
| A14-027 | Adapter cap and plug set | G18-828002 | Consists of covers, caps, and plugs for all electrical, hydraulic, and mechanical disconnects; duct, pipe, interface openings, and areas to be protected from shipping and handling damage. |
| A14-028 | Optical alignment set | G17-824010 | Mounted on a mobile stand with provisions for raising and lowering. Used to establish precise vertical planes for weight and balance operations. |
| A14-035 | Vacuum cleaner | ME901-0064-0002 | A mobile unit used to clean boilerplate internally of all dust and metallic particles. Incorporates a multiple stage suction unit, and is electrically powered from a 480/277V 15-ampere 3-phase 4-wire 60-cycle circuit. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| A14-036 | Ground air circulating unit | G16-824150 | Supplies fresh ambient air, to control temperature and humidity, to interior of command module during testing, maintenance, and preflight periods. Consists of blower, flexible duct, and hatchway adapter. Blower delivers approximately 800 cfm of air and is driven by 1/2-hp 115-volt single-phase 1725-rpm electric motor. |
| A14-037 | Adapter and duct set | G16-824200-101 | Conducts air from A14-011 ground cooling cart through open command module hatchway. |
| A14-038 | Launch escape motor, dummy | G15-820020 | A previously fired motor using an inert substance to simulate propellant. Weight and center of gravity same as actual motor. |
| A14-040 | Launch escape pitch motor, dummy | G15-820080 | A previously fired motor using an inert substance to simulate propellant. Weight and center of gravity same as actual motor. |
| A14-046 | Crane control, auxiliary | G14-820001 | Has an upper eye which connects to crane hook and a lower eye which connects to load. Provides precise movement during raising and lowering operations. |
| A14-047 | Box level | G14-820045 | Establishes true vertical and horizontal planes used in conjunction with weight and balance fixtures to determine center of gravity of launch escape system and spacecraft modules. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| A14-130 | Wrench set, LES tower explosive bolt | G15-824080 | Consists of three special hexagon wrenches, a thread protector for explosive bolt, and a container lined with foam rubber. Wrenches allow insertion into small openings in LES tower leg. |
| C14-021 | Telemetry ground station | ME478-0010-0001 | Equipment to support detailed functional tests, record data via telemetry links, provide recording capability, and limited real-time and quick-look capability during combined and integrated tests. |
| C14-029 | Launch escape sequencer bench maintenance equipment | G16-853400-201 | Will either assure proper operation of launch escape sequencer or help isolate any fault. Capable of checking either system in sequencer independently, or both systems simultaneously. |
| C14-032 | Antenna checkout group | G16-850400-101 | Mounted on a cart and may be hand-pushed or transported by forklift. Capable of verification of proper operation of spacecraft antenna and associated transmission lines, power dividers, connectors, multiplexers, and diplexers. |
| C14-051 | Pyrotechnic bench maintenance equipment | G16-852700-101 | Equipment for measuring resistance to hot bridgewire initiators prior to, and after installation. Also verifies continuity between sequencers and squibs. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| C14-112 | C-band radar transponder checkout unit | G16-852900 | Mobile roller-mounted unit used for operational checkout and adjustment of each C-band transponder in bench maintenance and in spacecraft. |
| C14-166 | C-band antenna coupler | G16-853650 | Provides spacecraft tracking information during all phases of near-earth flight. One antenna coupler is mounted over each C-band antenna. |
| C14-177 | Electrical cable set AMR | G16-852800 | Consists of approximately 38 cables. Lengths vary from 31 to 93 feet, approximately. Used to transfer electrical power, monitor and control signals between spacecraft and associated GSE during checkout and test program. |
| C14-180 | Electrical cable set | G16-853450 | Consists of approximately 38 cables. Lengths vary from 31 to 93 feet. Used to transfer electrical power, monitor and control signals between spacecraft and associated GSE during checkout and test program. |
| C14-186 | Electrical cable set | G16-850065 | Consists of 50 cables. Lengths vary from 6 to 70 feet. Used to transfer electrical power, monitor and control signals between spacecraft and ground support equipment. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| C14-191 | Electrical terminal distributor | G16-851300 | Cabinet mounted to floor in test area. Provides connection points between spacecraft and various GSE units. Contains fuses, terminal blocks, and a power distribution panel with circuit breakers. |
| C14-192 | Umbilical junction box | G16-852850 | Approximately 60 inches high, 48 inches wide, and 12 inches deep. Constructed of stainless sheet steel. Contains approximately 40 terminal blocks capable of handling 740 wires. Used to make electrical interconnections between spacecraft and ground support equipment. |
| C14-414 | Launch control group | G16-853950-101 | Consists of five system panels on drawer assemblies mounted in a five-bay equipment rack. Panels are: test conductor panel, electrical power system panel, instrumentation and communication systems panel, environmental control system panel, and launch escape system panel. |
| C14-420 | Data distribution and recording console (Frame only) | G16-850500-101<br>(G16-850500) | Provides a means of integrating data signals from spacecraft, Marshall Space Flight Control Panel (MSFC), and NAA ground support equipment panels. Also provides monitoring and/or recording capability for all signals routed through console. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| H14-011 | Launch escape alignment stand | G15-810042 | Consists of two rails mounted on four adjustable legs. Rails are 48 inches apart and will attach to ends of rail system of H14-052. |
| H14-016 | Launch escape system weight and balance fixture | G15-810029 | Consists of two welded square-tubing structures bolted together and supported by short jacks. Upper surface of frame has six level mounting pads for mounting load cells and a laterally and vertically adjustable cradle to support and position LES components. |
| H14-017 | Spacecraft weight and balance fixture | G14-810007 | Constructed of aluminum tubing which forms a support ring for service module. Adjustable pads are provided on ring to match fittings on aft end of command module. |
| H14-018 | Escape tower support | G15-810026 | Welded tubular structure, equipped with four clamps to secure tower and four roller assemblies to rails of H14-011 alignment stand and H14-052 positioning trailer. |
| H14-021 | Ground support equipment handling cart | G14-810050 | Can be used to transport lightweight miscellaneous components, such as load cell kits and removable pieces of equipment, tools, etc. |
| H14-027 | Adapter, rail transfer skirt | G15-810051 | Rail adapter is a low-carbon steel, tubular, welded assembly which supports model H14-029 skirt sling. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| | | | Provides all necessary adjustments for mounting skirt on launch escape motor. |
| H14-029 | Sling, flow skirt | G15-810058 | Sling is a low-carbon steel, tubular, welded circular ring with four drilled lugs. Ring is attached to structural skirt by bolting to matching holes on skirt. |
| H14-030 | Service module support | G17-818130-101 | Support base used to support service module; or service module, insert, adapter, command module, and launch escape tower in a stacked configuration. |
| H14-040 | Electronic weighing kit, 3000-pound capacity | G14-810090 | Provides a finely accurate means of measuring weights to determine weight and center of gravity of spacecraft adapter and launch escape system components within weight capacity of kit. |
| H14-041 | Electronic weighing kit, 30,000-pound capacity | G14-810095 | Provides a finely accurate means of measuring weights to determine weight and center of gravity of command module, service module, and launch escape system. |
| H14-042 | Hoist beam, service module and spacecraft adapter | G17-818108 | Hoist beam is structural steel formed into an X-shape with attach points at end of each leg. Four cables attach to hoist beam and join at a common lifting eye at other end. Used to hoist, handle, rotate, position for weight and |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| | | | balance, and provide tie-down during transportation of service module or spacecraft adapter. |
| H14-043 | Sling, jettison motor | G15-810002-101 | Consists of a wire-rope cable with an attachment fitting at either end. Lifting eye, in center of cable, is provided for a crane hook. Removal of four screws from jettison motor assembly provides hole patterns for attachment of this sling. |
| H14-052 | Positioning trailer, narrow base | G16-810150 | Trailer has two rails that are 48 inches apart. A combination of hydraulic and mechanical actuators provide pitch, roll, yaw, and vertical lift to the two rails. |
| H14-054 | Jettison motor support | G15-810027 | Consists of two rings which attach near either end of jettison motor. Motor can be rotated or moved longitudinally when rings engage rollers on H14-011 workstand. Motor support is used during assembly of pitch or launch motors to jettison motor. |
| H14-055 | Launch escape motor support | G15-810028 | Consists of two rings which attach to launch escape motor. Motor can be rotated or moved longitudinally when installed on H14-011 workstand. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| H14-057 | Forward compartment shield sling | G16-810040-101 | Consists of four cable assemblies terminating at one end in a lift eye and attaching to four identical swaged clevis fittings at other end. Swaged fittings are pinned to other fittings which attach to forward compartment heat shield. |
| H14-074 | Sling, spacecraft (with launch escape system) | G15-818001-101 | Multiple usage sling to erect launch escape system and hoist combined command module and launch escape system onto service module. |
| H14-083 | Cradle, transport launch escape system | G15-810069-101 | Framework equipped with pads and straps to support launch escape system in a horizontal position for transportation. |
| H14-084 | Adapter, rollover | G15-810060-101 | Adapter is a rigid, self-contained base mounted on rollers; designed to attach to base of launch escape system tower legs and provide pivoting motion required to position LES from horizontal to vertical plane. |
| H14-085 | Sling, horizontal handling launch escape system, launch escape motor | G15-810066-101 | Used to handle launch escape system and launch escape motor in a horizontal position. Adjustment for varied centers of gravity is provided. |
| H14-086 | Support base assembly, tubular, boilerplate | G16-810039-101 | Base to support command module and/or aft heat shield during handling, servicing, and storage. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| H14-090 | Stand, access, recovery area | G16-810071-201 | Working access stand providing 360-degree access and a 15-foot by 15-foot working area around command module. |
| H14-091 | Stand, access, command module hatch | G16-810075 | Stand is an erector-type scaffold, supporting a railed platform with stairs extending to ground level. A pair of removable, tubular supports are provided for mounting A14-036 circulating blower. |
| H14-092 | Sling, pitch control, motor interstage structure | G14-810036 | Consists of a lifting ring, interface connecting brackets, and a cantilevered arm for hoisting interstage structure. |
| H14-093 | Boatswain's chair | G16-810087<br>G16-810087-101 | Designed to support a man in a sitting position, and provide freedom of movement to gain access to areas beyond reach of access stands. Can be lifted vertically by utilizing facility crane or similar means. |
| H14-094 | Sling, jettison motor, pitch control motor, and nose cone | G14-810037 | Consists of a beam approximately 41 inches long with a hook at either end and a lifting ring in the center. Two sling bands are provided to fit around motor combination for hoisting. |
| H14-096 | Hook, ballast pickup, launch escape system | G14-810039 | Hoisting device is L-shaped with an indexing pin for ballast on one end and a lifting eye on other end. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| H14-097 | Stand, access, launch escape system build-up | G15-810150 | Pipe-constructed framework covered with a 4- by 7-foot platform. Stand is mounted on four casters and may be manually operated through a 3- by 7-foot height range by a hydraulic cylinder. |
| H14-099 | Wrench, pitch control motor LES | G15-810050 | Socket-type wrench for tightening pitch control motor mounting nut V14-300412. |
| H14-101 | Access platform | G17-810180 | Welded tubular, variable height, movable platform, used for access to command module, service module, and adapter insert. |
| H14-109 | Access stand, service module (external) | G17-810070 | Constructed of light tubular scaffoldings that form a rigid structure around service module. A square platform, with a circular cutout to clear service module, is installed at the 20-foot level. A light-weight plastic cover, an air conditioning system, and incandescent lighting is also provided. |
| H14-111 | Access ladder, command module hatch | G16-810162 | Stepladder that may be positioned on H14-109 workstand platform and allowed to rest against command module for entrance to hatch. |
| H14-126 | Beam, weight and balance, service module and adapter | G17-810200 | Approximately 155 inches long with a lifting eye in center and attachment fittings at ends. Will attach to either end of adapter and to lower end of service module for weight and balance operation. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| H14-127 | Cable and fitting set, weight and balance, service module adapter | G17-810220 | Consists of conical-shaped buttons with a shank for installation into aft interface of spacecraft adapter and/or extension. Used during weight and balance operations. |
| H14-131 | Spacecraft vertical transport vehicle | ME183-0024-0001 | A large, tandem-axle semi-trailer used to transport boilerplate spacecraft minus launch escape system. |
| H14-144 | Platform maintenance, mobile | ME183-0027-0001 | Self-powered, mobile, variable height platform. Can be used up to 60 feet in height, with a capacity of two men. |
| H14-147 | Service module, internal work platform | G17-818340 | Two-level platform to be used inside service module. |
| H14-9001 | Sling set, command module test vehicle | G16-810004 | Consists of three cable assemblies terminating in a common lift eye at one end and bolting into three bracket assemblies at other end. These bracket assemblies in turn attach to brackets on sides of boilerplate command module. |
| H14-9006 | Sling set, weight and balance | G16-810010-101 | Consists of two cable assemblies terminating in a lift eye at one end and attaching to a pair of trunnion fittings on other end. These fittings are bolted to sides of command module to hoist and/or rotate it for establishing precise center of gravity in all three planes. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| H14-9015 | Jack set, weight and balance | G16-810012<br>G16-810012-101 | Consists of three jacks, pads, and a fitting. Used to support and level command module, service module, or adapter for determining weight and center of gravity measurements. |
| H14-9056 | Heat shield sling | G16-810027-101 | For handling command module aft heat shield during placement or removal from transportation dollies and fixtures. |
| H14-9059 | Service module and spacecraft adapter, weight and balance fixture | G17-810003 | Fixture used to determine weight and center of gravity of service module or adapter. |
| H14-9073 | Spacecraft boilerplate sling | G14-810001 | Consists of three cable assemblies terminating in a lift eye at one end and swaged fittings at other end; attached to a tee-shaped structure with a collapsible arm. Adjustable turnbuckles extend from this structure and bolt to attach fittings, which in turn fasten to spacecraft. Sling attaches to command module at LES attach points. |
| H14-9076 | General purpose dolly | G16-810033-101 | Consists of a welded, rectangular steel frame, four lateral support brackets, and necessary tie-down brackets. Unit has lockable casters bolted to each corner of frame and a removable tow bar assembly with swivel-type brackets in front and back of frame. |

Table 7-2. Ground Support Equipment (Cont)

| Model No. | Nomenclature | Part No. | Description |
|---|---|---|---|
| H14-9077 | Sling, access door, service module | G17-810001 | Consists of a single cable with swaged fittings at each end. A spreader bar is positioned to prevent excessive compression loading of panels that are hoisted. Sling is used for panels on service module, insert, and adapter. |
| S14-015 | Battery charging unit | G14-840100-101 | Unit has a d-c voltmeter, d-c ammeter, and a circuit breaker for a-c line protection. Unit is used to charge spacecraft batteries. |
| S14-034 | Fluid distribution system | G14-848018 | Consists of tubing, flexhoses, relief valves, and necessary supports, etc., required to route and secure tubing between GSE and spacecraft. Used during checkout at Downey, California. |
| S14-036 | Fluid distribution system | G14-848018 | Consists of tubing, flexhoses, relief valves, and necessary supports, etc., required to connect GSE for servicing and checkout of spacecraft fluid system. |
| S14-052 | Water-glycol, cooling unit | G16-848021-101 | Contained in a steel enclosure and mounted on skids. Used to fill and circulate water-glycol solution through environmental control system at controlled temperatures. |

# SECTION VIII

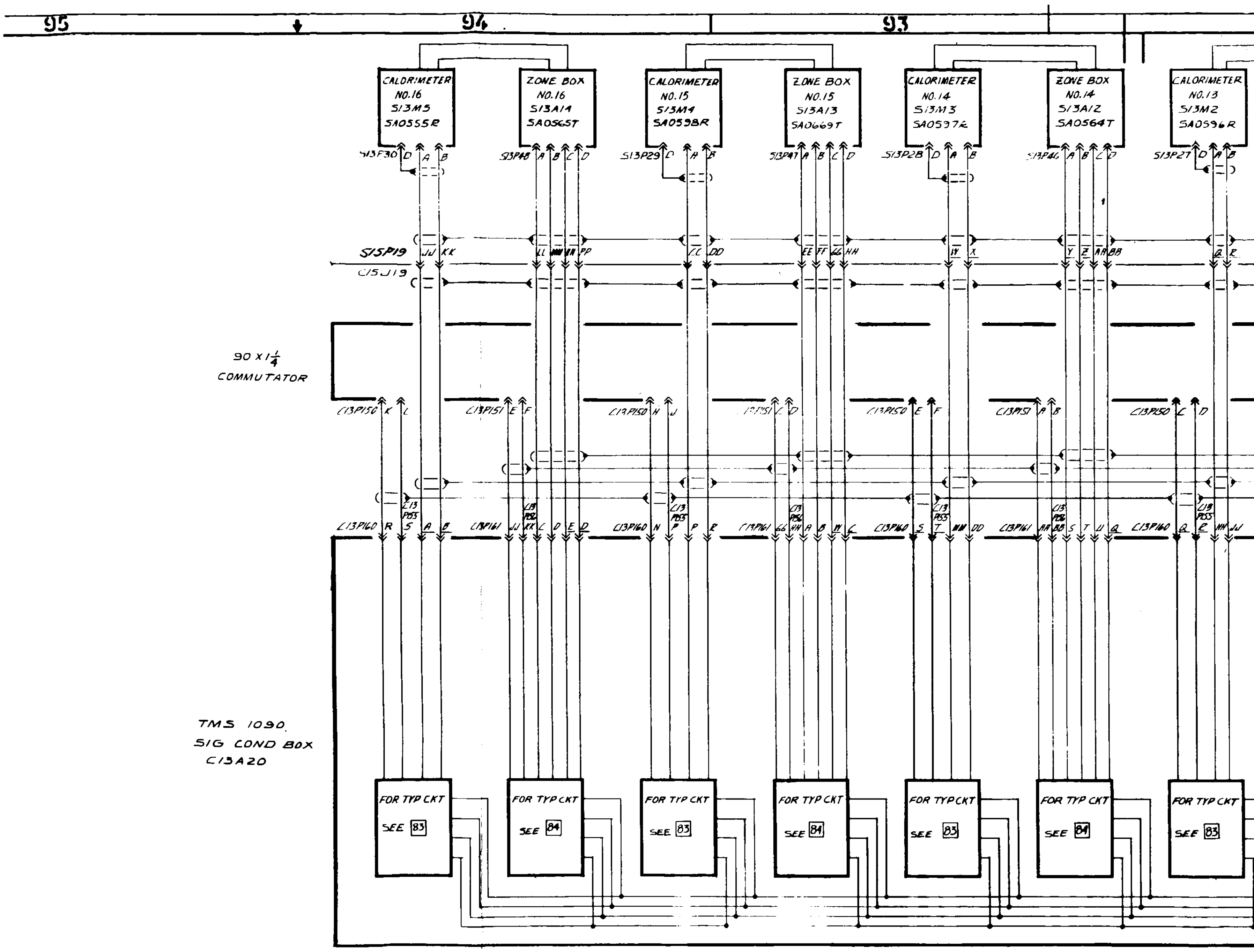
# ELECTRICAL SCHEMATICS

## 8-1. PURPOSE.

8-2. This section contains the electrical wiring schematics for boilerplate 13. (See figures 8-1 and 8-2.)

## 8-3. SCHEMATIC DIAGRAMS.

8-4. The combined systems schematic diagram for boilerplate 13 is shown in figure 8-1, and the combined systems schematic for the associated ground support equipment is shown in figure 8-2. The bottom edge of the GSE schematic is made to match the top edge of the boilerplate 13 schematic; therefore, by matching zone numbers at the bottom of figure 8-2 with zone numbers at the top of figure 8-1, the circuitry from GSE to the boilerplate can be easily traced. The GSE combined systems schematics in figure 8-2 are for use during checkout in the hangar area only. For boilerplate 13 and GSE combined systems schematic of launch pad checkout configuration, refer to engineering drawing No. B14-900013 (A change).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94
93
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ZONE BOX NO.16 S13A14 SA0565T
CALORIMETER NO.15 S13M4 SA0598R
ZONE BOX NO.15 S13A13 SA0669T
CALORIMETER NO.14 S13M3 SA0597R
ZONE BOX NO.14 S13A12 SA0564T
CALORIMETER NO.13 S13M2 SA0596R
S15P19
C15J19
90 X 1/4
COMMUTATOR
TMS 1090
SIG COND BOX
C13A20
FOR TYP CKT SEE 83
FOR TYP CKT SEE 84
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FOR TYP CKT SEE 84
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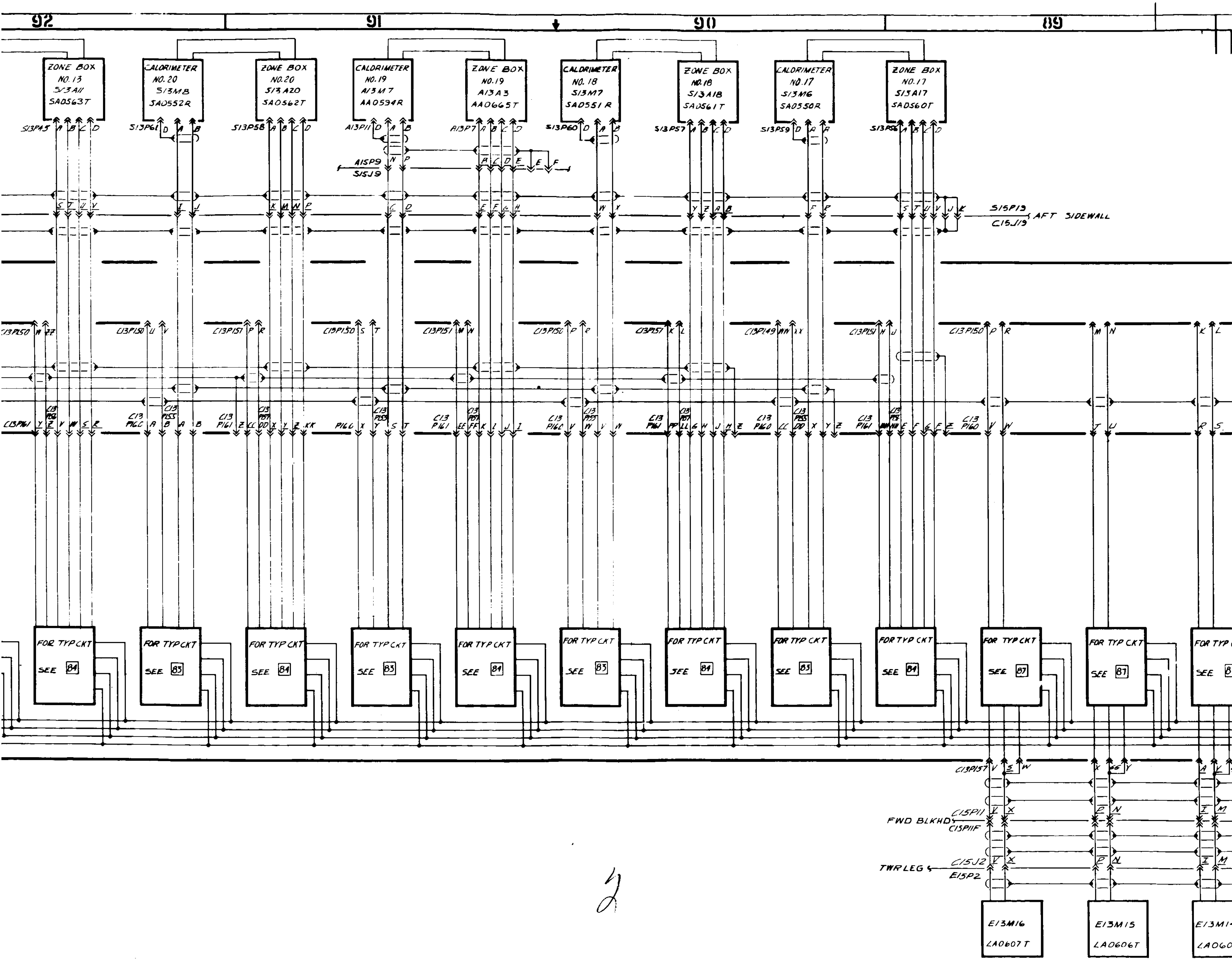
FOR TYP CKT SEE 84
FOR TYP CKT SEE 83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91
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89
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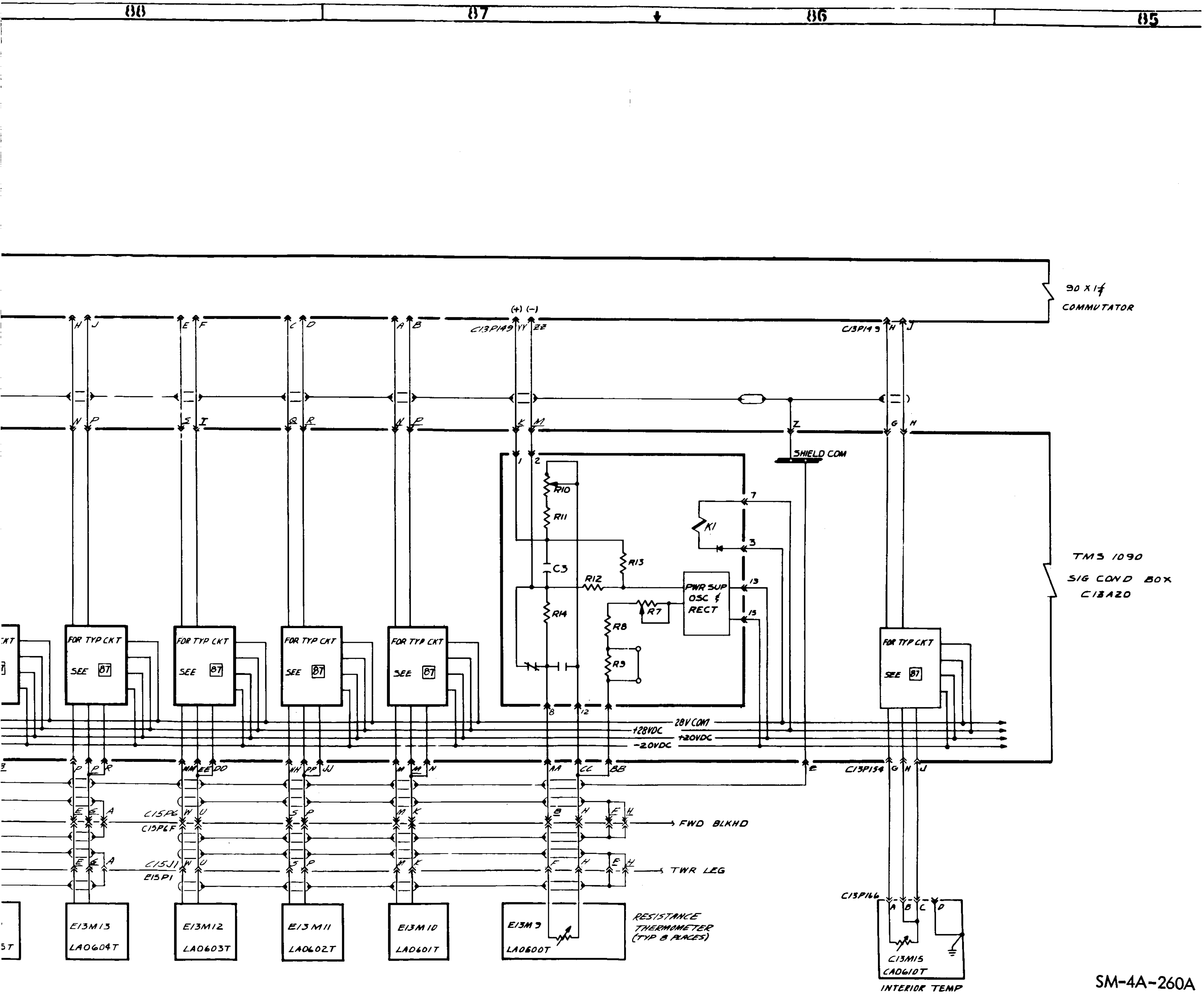
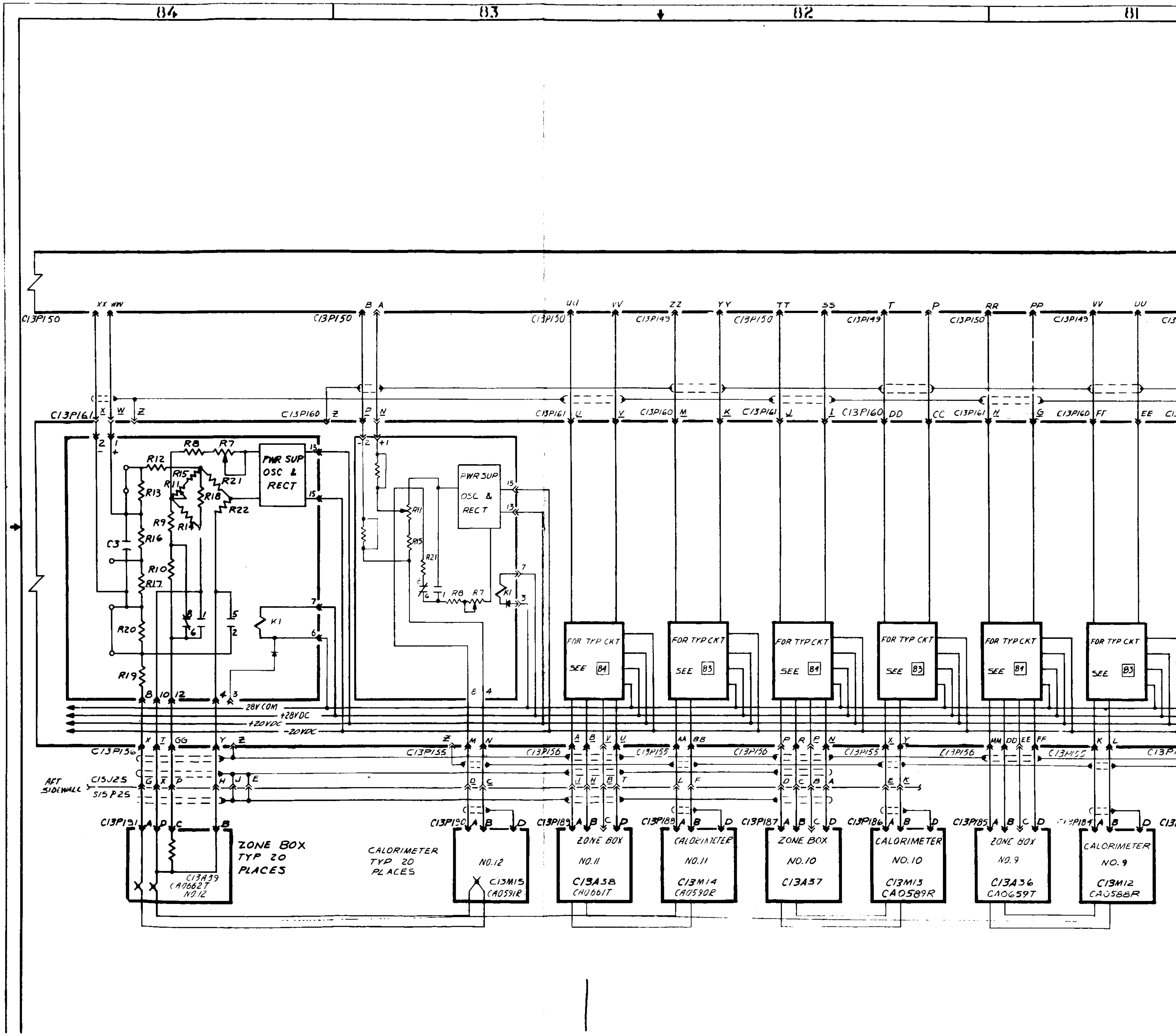
ZONE BOX NO. 20 S13A20 SA0562T
CALORIMETER NO. 19 A13M7 AA0594R
ZONE BOX NO. 19 A13A3 AA0665T
CALORIMETER NO. 18 S13M7 SA0551R
ZONE BOX NO. 18 S13A18 SA0561T
CALORIMETER NO. 17 S13M6 SA0550R
ZONE BOX NO. 17 S13A17 SA0560T
A15P9
S15J9
S15P13
C15J13
AFT SIDEWALL
FOR TYP CKT SEE 84
FOR TYP CKT SEE 83
FOR TYP CKT SEE 87
FWD BLKHD
C15P11
C15P11F
TWR LEG
C15J2
E15P2
E13M16 LA0607T
E13M15 LA0606T
2




SM-4A-260A

Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 1 of 8)


84
83
82
81
C13P150
PWR SUP OSC & RECT
ZONE BOX TYP 20 PLACES
CALORIMETER TYP 20 PLACES
AFT SIDEWALL
28V COM
+28VDC
+20VDC
-20VDC
FOR TYP CKT SEE 84
FOR TYP CKT SEE 83
ZONE BOX NO.11 C13A38 CA0661T
CALORIMETER NO.11 C13M14 CA0590R
ZONE BOX NO.10 C13A37
CALORIMETER NO.10 C13M13 CA0589R
ZONE BOX NO.9 C13A36 CA0659T
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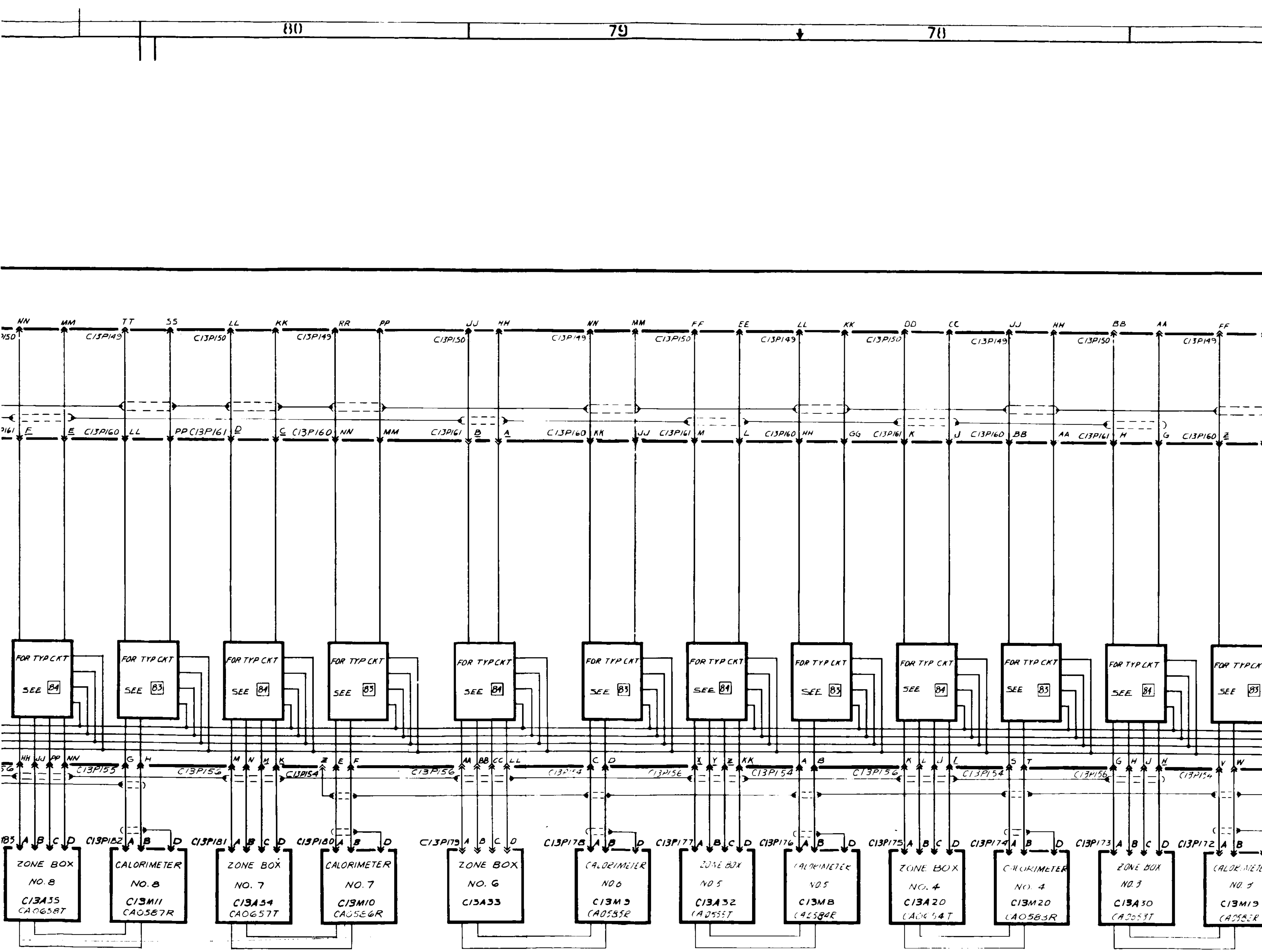

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79
78
C13P149
C13P150
C13P160
C13P161
FOR TYP CKT SEE 84
FOR TYP CKT SEE 83
C13P154
C13P155
C13P156
ZONE BOX NO. 8 C13A35 CA0658T
CALORIMETER NO. 8 C13M11 CA0587R
ZONE BOX NO. 7 C13A34 CA0657T
CALORIMETER NO. 7 C13M10 CA0586R
ZONE BOX NO. 6 C13A33
CALORIMETER NO 6 C13M9 CA0585R
ZONE BOX NO 5 C13A32
CALORIMETER NO 5 C13M8
ZONE BOX NO. 4 C13A20
CALORIMETER NO. 4 C13M20 CA0583R
ZONE BOX NO. 3 C13A30
CALORIMETER NO. 3 C13M19
C13P182
C13P181
C13P180
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C13P178
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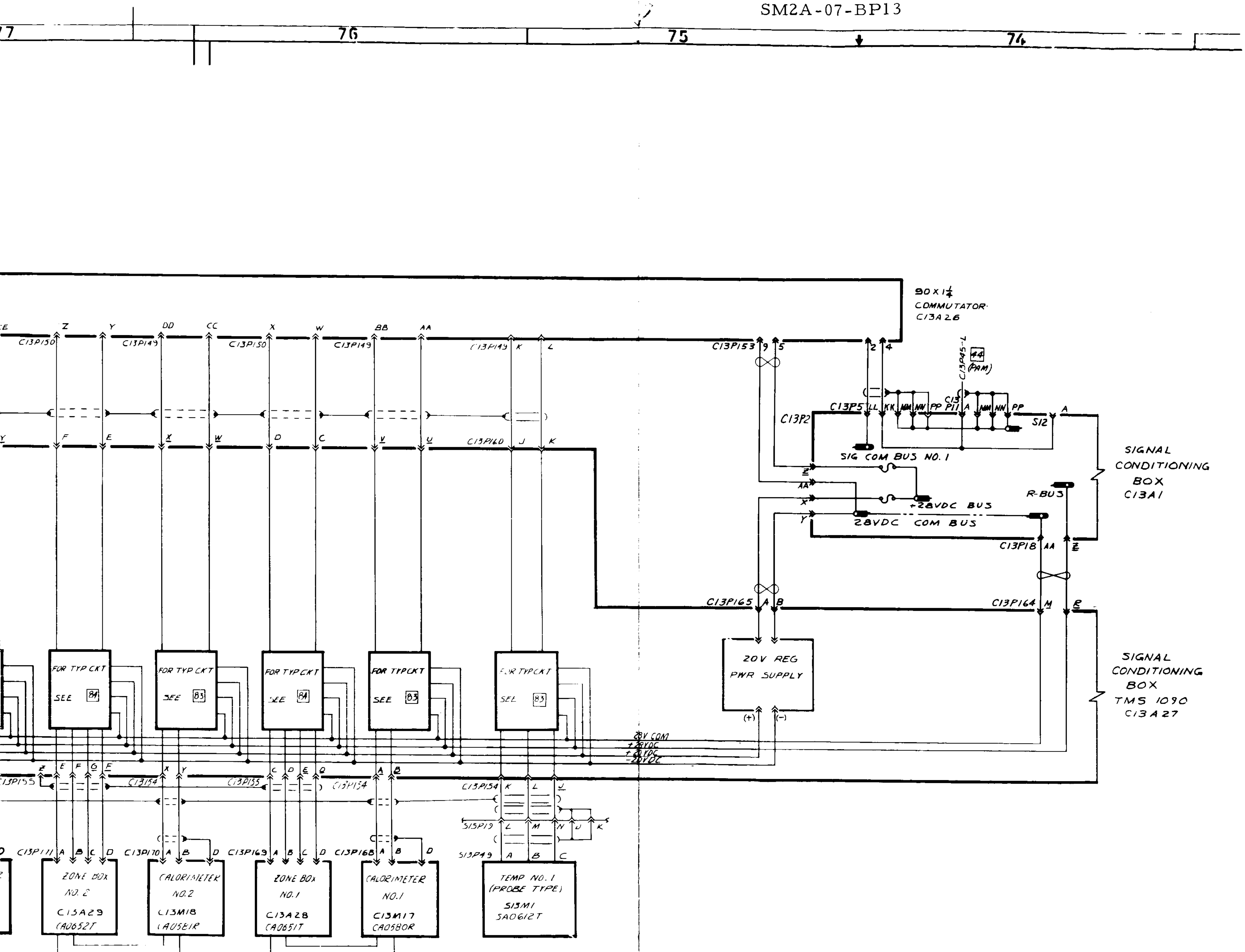
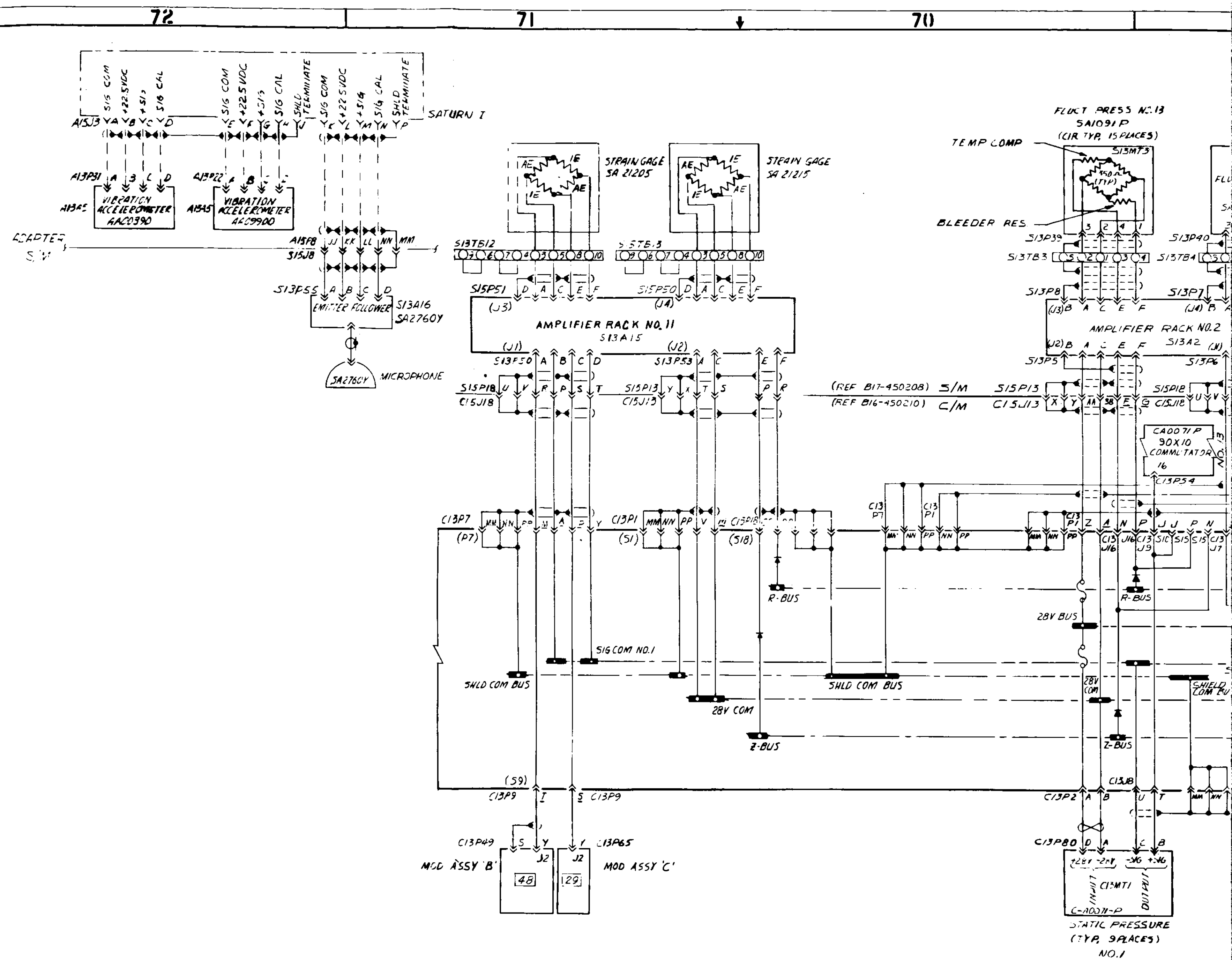
C13P176
C13P175
C13P174
C13P173
C13P172


2




SM-4A-261A

Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 2 of 8)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71
70
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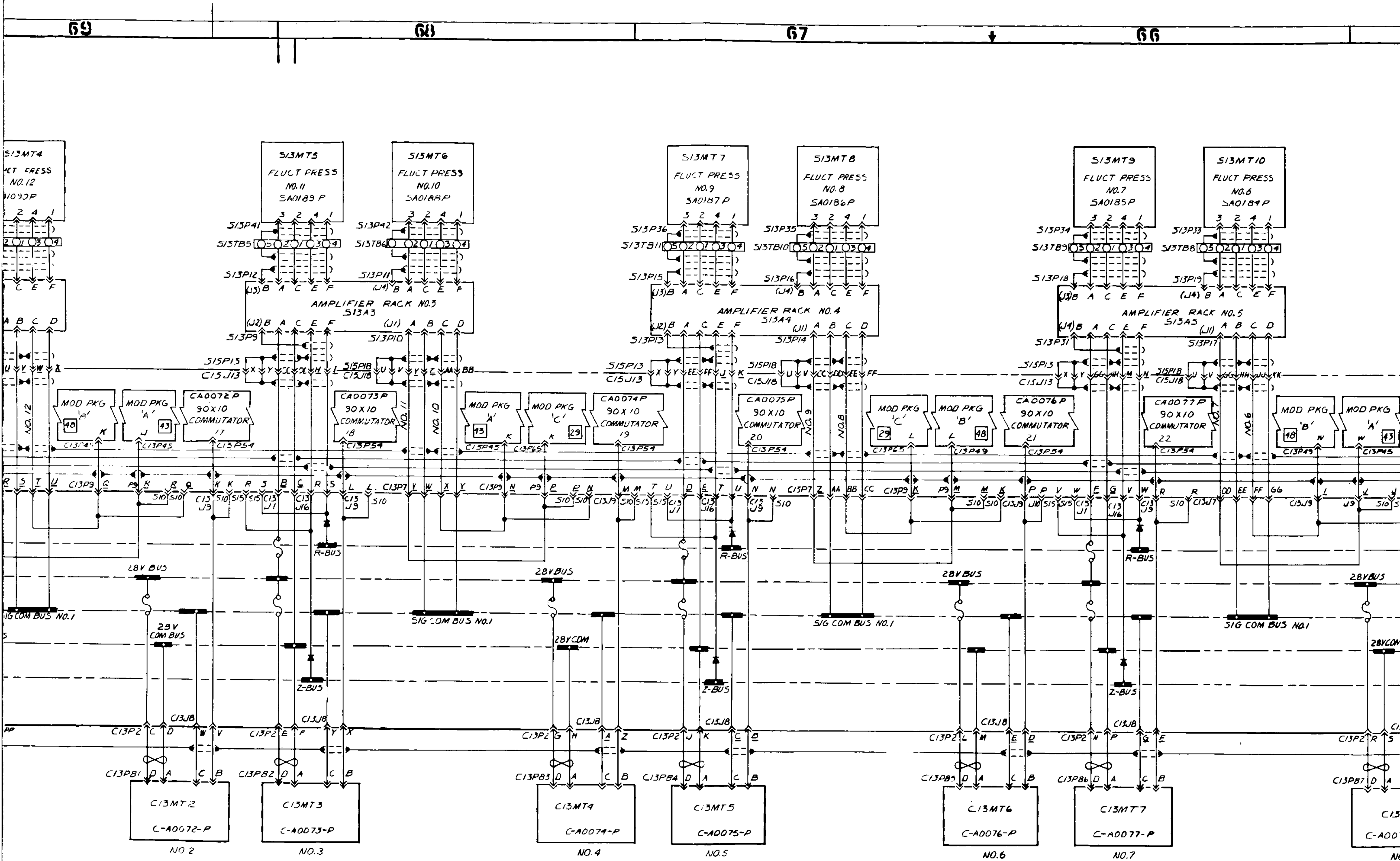
VIBRATION ACCELEROMETER 6AC0990
VIBRATION ACCELEROMETER 6AC9900
SIG COM
+22.5 VDC
SIG CAL
SHLD TERMINATE
A15J3
A13P31
A13P22
ADAPTER
A15P8
S15J8
S13P55
EMITTER FOLLOWER
S13A16
SA2760Y
MICROPHONE
STRAIN GAGE SA 21205
STRAIN GAGE SA 21215
S13TB12
S15P51
S15P50
AMPLIFIER RACK NO.11
S13A15
S13P50
S13P53
S15P18
C15J18
S15P13
C15J13
(REF B17-450208) S/M
(REF B16-450210) C/M
FLUCT PRESS NO.13
SA1091P
(CIR TYP, 15 PLACES)
TEMP COMP
S13MT3
BLEEDER RES
S13P39
S13TB3
S13P40
S13TB4
S13P8
S13P7
AMPLIFIER RACK NO.2
S13A2
S13P5
S13P6
S15P18
C15J18
CA0071P
90X10
COMMUTATOR
C13P54
C13P7
C13P1
C13P18
R-BUS
28V BUS
SIG COM NO.1
SHLD COM BUS
28V COM
Z-BUS
SHIELD COM BUS
C13P9
C13J8
C13P2
C13P49
C13P65
MOD ASSY 'B'
MOD ASSY 'C'
48
129
C13P80
C13MT1
INPUT
OUTPUT
C-A0071-P
STATIC PRESSURE
(TYP, 9 PLACES)
NO.1



69
68
67
66
S13MT5
FLUCT PRESS
NO.11
SA0183 P
S13MT6
FLUCT PRESS
NO.10
SA0188P
S13MT7
FLUCT PRESS
NO.9
SA0187 P
S13MT8
FLUCT PRESS
NO.8
SA0186P
S13MT9
FLUCT PRESS
NO.7
SA0185P
S13MT10
FLUCT PRESS
NO.6
SA0184P
AMPLIFIER RACK NO.3
S13A3
AMPLIFIER RACK NO.4
S13A4
AMPLIFIER RACK NO.5
S13A5
MOD PKG
CA0072 P
90 X 10
COMMUTATOR
17
CA0073P
90 X 10
COMMUTATOR
18
CA0074P
90 X 10
COMMUTATOR
19
CA0075P
90 X 10
COMMUTATOR
20
CA0076P
90 X 10
COMMUTATOR
21
CA0077P
90 X 10
COMMUTATOR
22
28V BUS
28V COM BUS
SIG COM BUS NO.1
R-BUS
Z-BUS
C13MT2
C-A0072-P
NO.2
C13MT3
C-A0073-P
NO.3
C13MT4
C-A0074-P
NO.4
C13MT5
C-A0075-P
NO.5
C13MT6
C-A0076-P
NO.6
C13MT7
C-A0077-P
NO.7


2

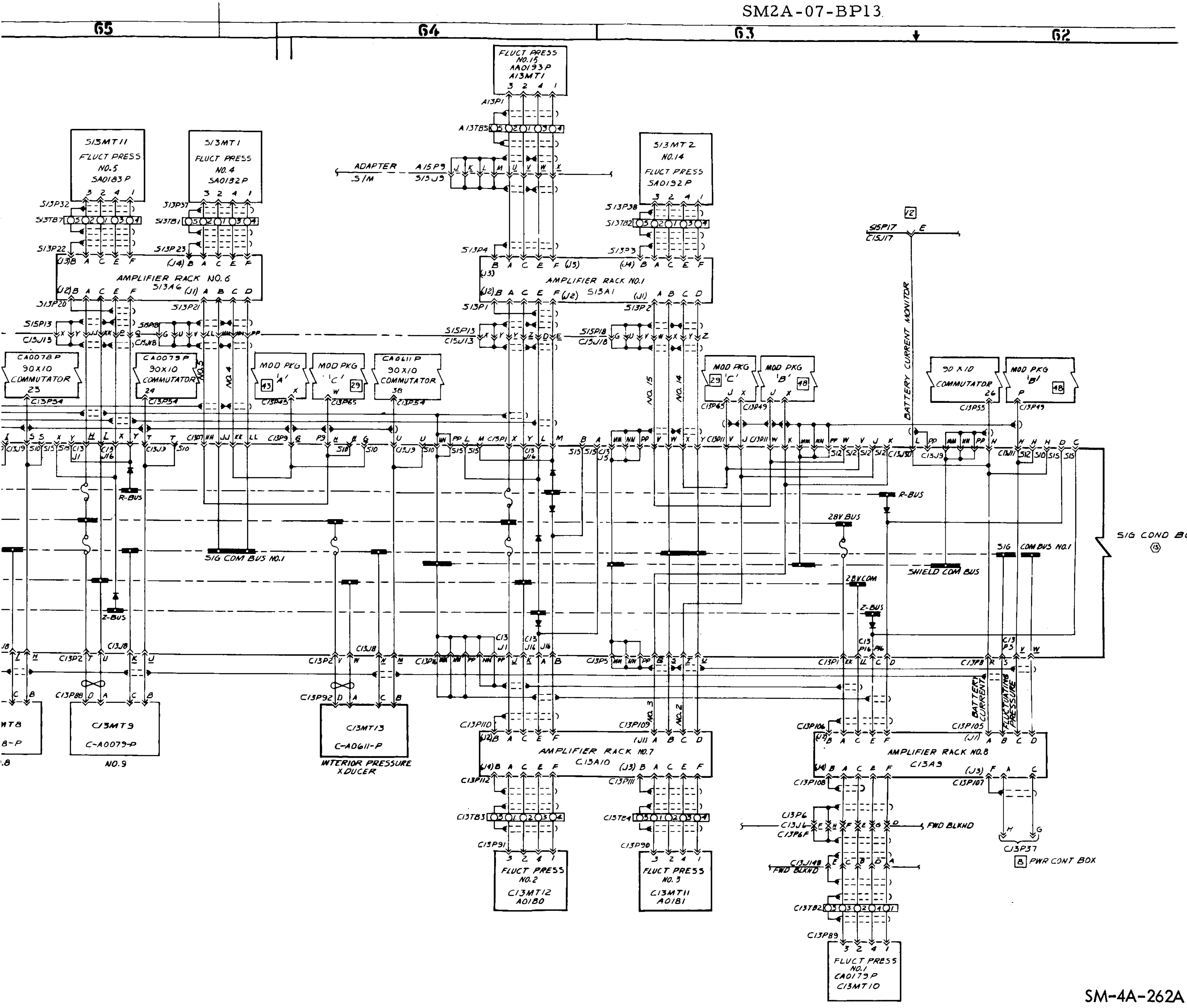
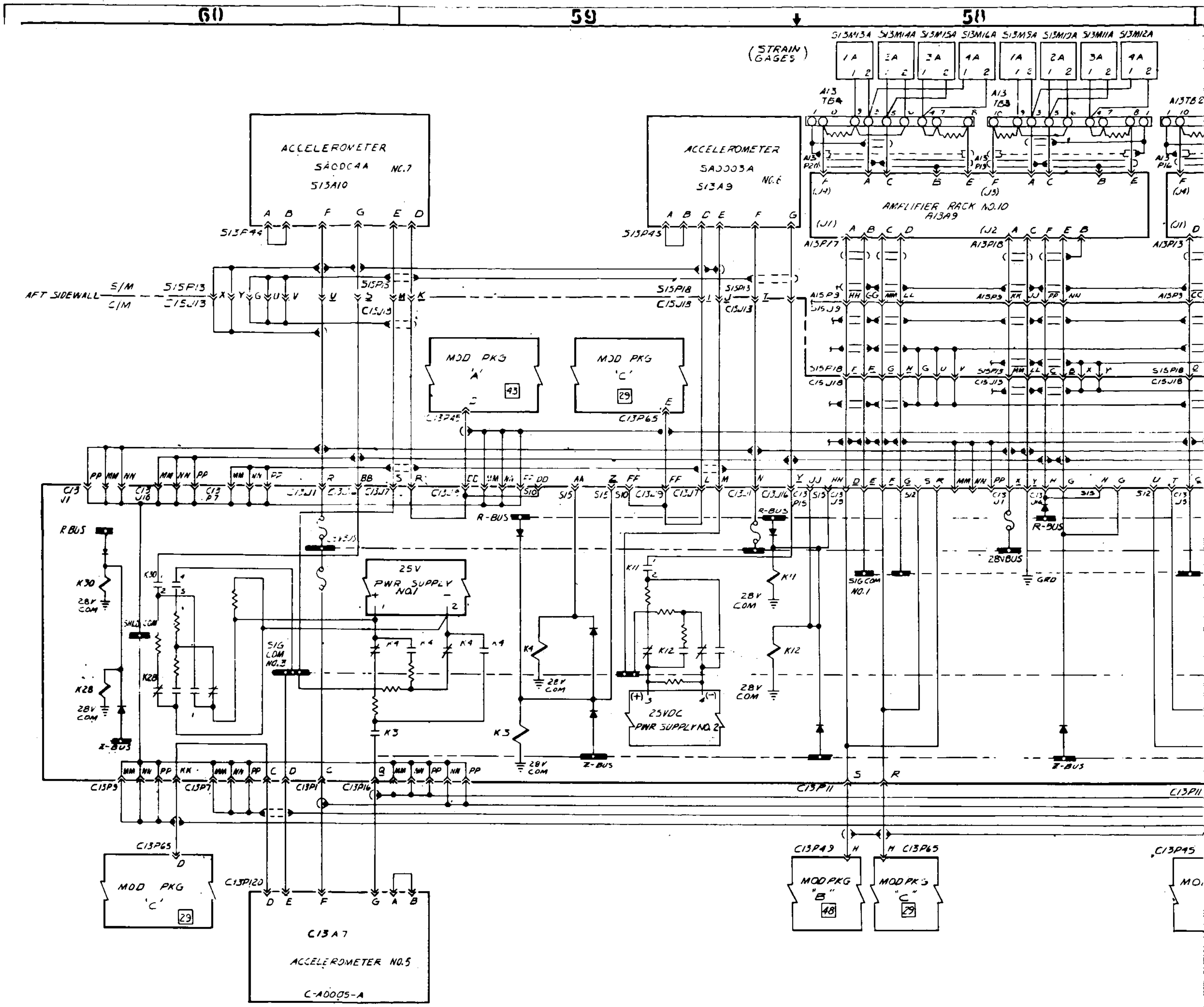
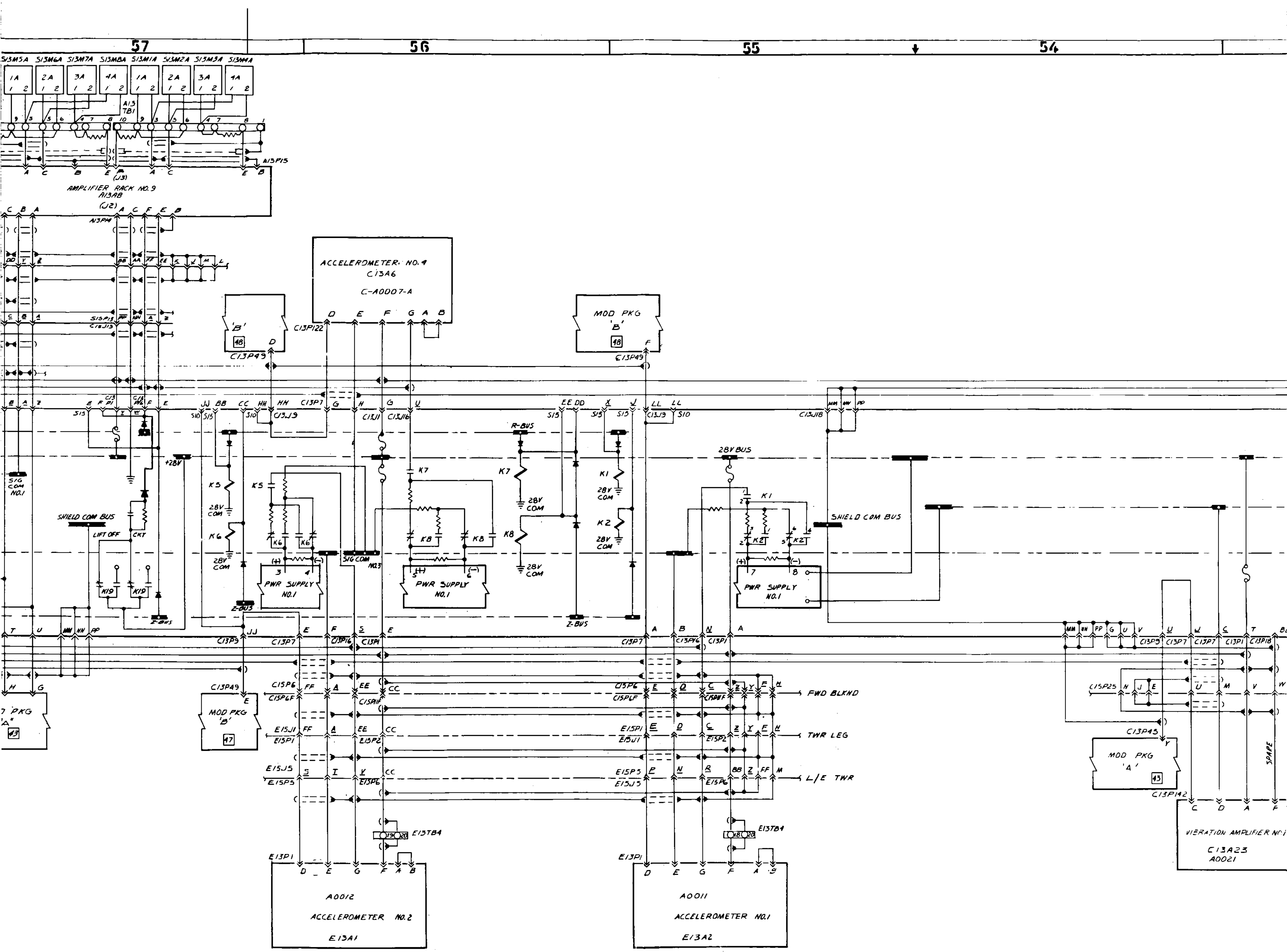
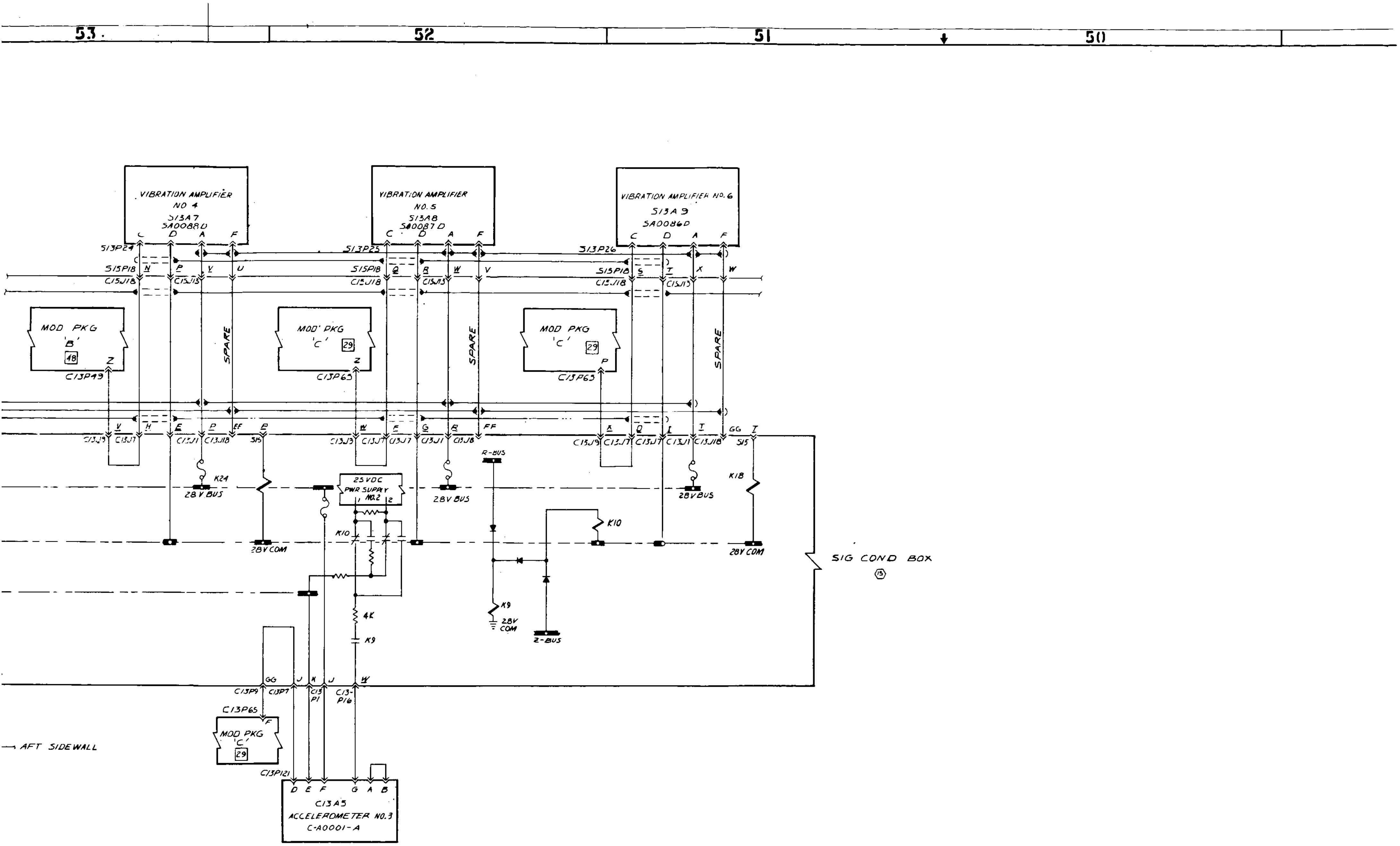



Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 3 of 8)


60
59
58
(STRAIN GAGES)
ACCELEROMETER
SA0DC4A
NO.7
513A10
ACCELEROMETER
SA0D03A
NO.6
513A9
AMPLIFIER RACK NO.10
A13A9
AFT SIDEWALL
S/M
C/M
MOD PKG 'A'
43
MOD PKG 'C'
29
25V PWR SUPPLY NO.1
25VDC PWR SUPPLY NO.2
R-BUS
Z-BUS
28V COM
SIG COM NO.3
SIG COM NO.1
28V BUS
GRD
MOD PKG 'C'
29
C13A7
ACCELEROMETER NO.5
C-A0005-A
MOD PKG "B"
48
MOD PKG "C"
29


57
56
55
54
AMPLIFIER RACK NO. 9
A13A8
ACCELEROMETER NO. 4
C13A6
C-A0007-A
MOD PKG
'B'
SHIELD COM BUS
LIFT OFF
PWR SUPPLY
NO. 1
SIG COM
28V BUS
R-BUS
Z-BUS
FWD BLKHD
TWR LEG
L/E TWR
MOD PKG
'A'
A0012
ACCELEROMETER NO. 2
E13A1
A0011
ACCELEROMETER NO. 1
E13A2
VIBRATION AMPLIFIER NO. 1
C13A23
A0021
E13TB4
SPARE

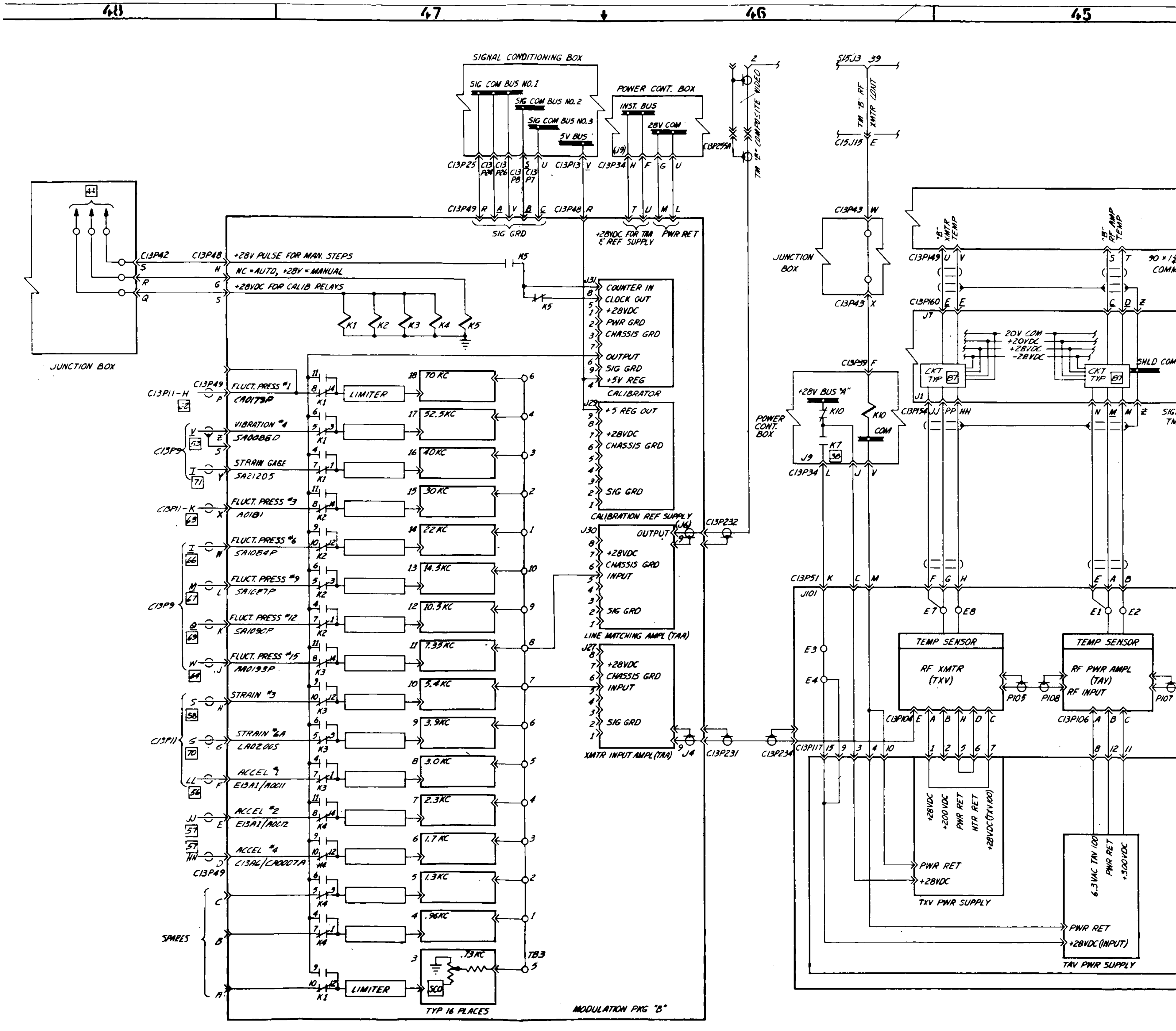
2

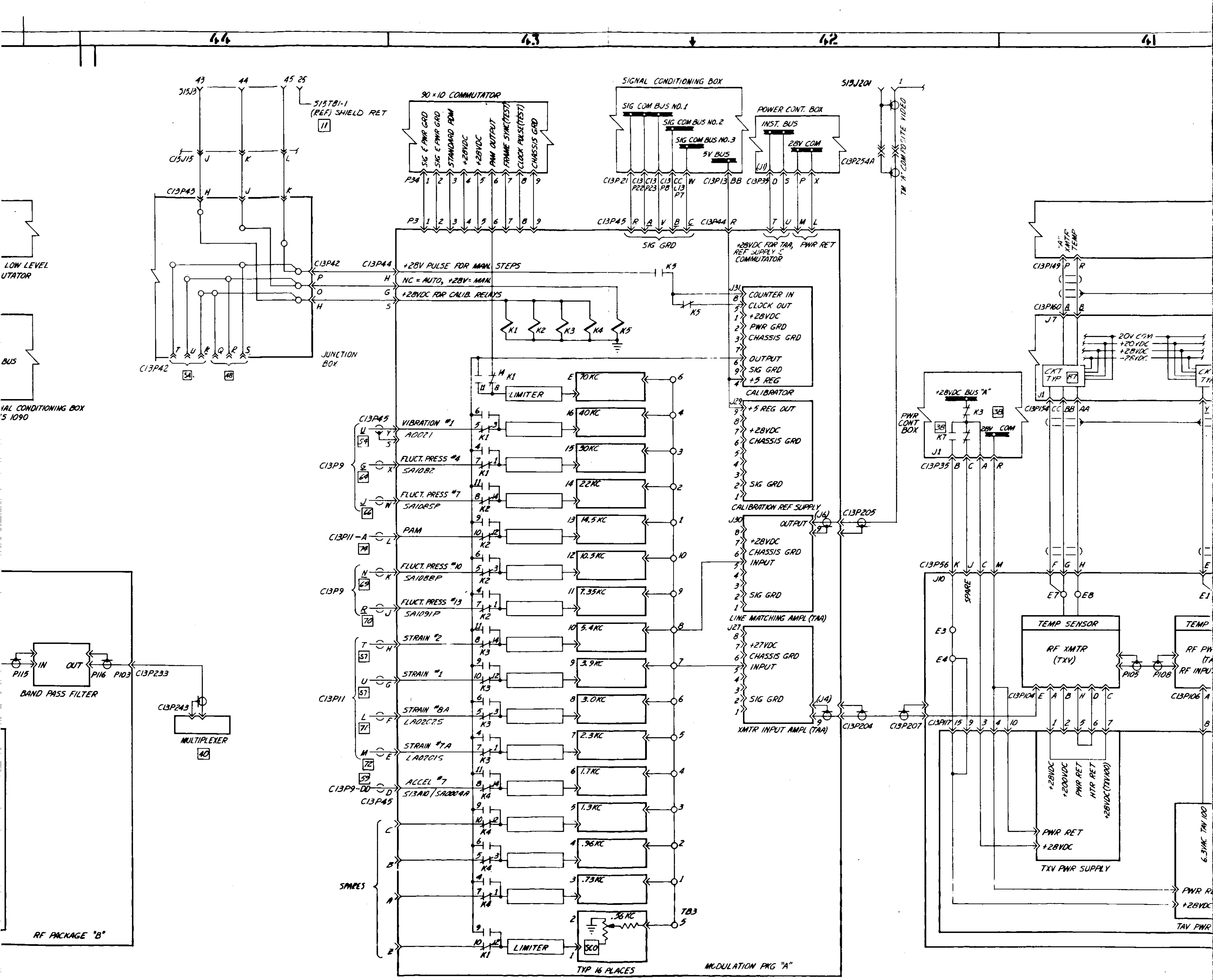



3

SM-4A-263B

Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg B) (Sheet 4 of 8)


48
47
46
45
SIGNAL CONDITIONING BOX
SIG COM BUS NO.1
SIG COM BUS NO.2
SIG COM BUS NO.3
5V BUS
POWER CONT. BOX
INST. BUS
28V COM
COMPOSITE VIDEO
TM "B" RF XMTR CONT
SIG GRD
+28VDC FOR TAA & REF SUPPLY
PWR RET
JUNCTION BOX
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V = MANUAL
+28VDC FOR CALIB RELAYS
COUNTER IN
CLOCK OUT
+28VDC
PWR GRD
CHASSIS GRD
OUTPUT
SIG GRD
+5V REG
CALIBRATOR
+5 REG OUT
CALIBRATION REF SUPPLY
LINE MATCHING AMPL (TAA)
INPUT
XMTR INPUT AMPL (TAA)
FLUCT. PRESS #1
VIBRATION #4
STRAIN GAGE
FLUCT. PRESS #3
FLUCT. PRESS #6
FLUCT. PRESS #9
FLUCT. PRESS #12
FLUCT. PRESS #15
STRAIN #3
STRAIN #6A
ACCEL #1
ACCEL #2
ACCEL #4
SPARES
LIMITER
70 KC
52.5KC
40KC
30KC
22KC
14.5KC
10.5KC
7.35KC
5.4KC
3.9KC
3.0KC
2.3KC
1.7KC
1.3KC
.96KC
.73KC
SCO
TYP 16 PLACES
TB3
MODULATION PKG "B"
POWER CONT. BOX
+28V BUS "A"
COM
20V COM
+20VDC
+28VDC
-28VDC
CKT TYP
SHLD COM
TEMP SENSOR
RF XMTR (TXV)
RF PWR AMPL (TAV)
RF INPUT
+28VDC
+200VDC
PWR RET
HTR RET
+28VDC (TXV 100)
TXV PWR SUPPLY
6.3VAC TAV 100
+300VDC
+28VDC (INPUT)
TAV PWR SUPPLY


44
43
42
41
S15TB1-1
(REF) SHIELD RET
JUNCTION BOX
LOW LEVEL
UTATOR
BUS
IAL CONDITIONING BOX
'S 1090
90 × 10 COMMUTATOR
SIG & PWR GRD
SIG & PWR GRD
STANDARD PDM
+28VDC
+28VDC
PAM OUTPUT
FRAME SYNC(TEST)
CLOCK PULSE(TEST)
CHASSIS GRD
SIGNAL CONDITIONING BOX
SIG COM BUS NO.1
SIG COM BUS NO.2
SIG COM BUS NO.3
5V BUS
POWER CONT. BOX
INST. BUS
28V COM
SIG GRD
PWR RET
TM "A" COMPOSITE VIDEO
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V= MAN.
+28VDC FOR CALIB. RELAYS
+28VDC FOR TAA, REF SUPPLY & COMMUTATOR
COUNTER IN
CLOCK OUT
+28VDC
PWR GRD
CHASSIS GRD
OUTPUT
SIG GRD
+5 REG
CALIBRATOR
+5 REG OUT
+28VDC
CHASSIS GRD
SIG GRD
CALIBRATION REF SUPPLY
OUTPUT
+28VDC
CHASSIS GRD
INPUT
SIG GRD
LINE MATCHING AMPL (TAA)
+27VDC
CHASSIS GRD
INPUT
SIG GRD
XMTR INPUT AMPL (TAA)
LIMITER
70KC
40KC
30KC
22KC
14.5KC
10.5KC
7.35KC
5.4KC
3.9KC
3.0KC
2.3KC
1.7KC
1.3KC
.96KC
.73KC
.56KC
SCO
LIMITER
TYP 16 PLACES
MODULATION PKG "A"
TB3
VIBRATION #1
A0021
FLUCT. PRESS #4
SA1082
FLUCT. PRESS #7
SA1085P
PAM
FLUCT. PRESS #10
SA1088P
FLUCT. PRESS #13
SA1091P
STRAIN #2
STRAIN #1
STRAIN #8A
LA02C25
STRAIN #7A
LA0701S
ACCEL #7
S13A10 / SA0004A
SPARES
BAND PASS FILTER
IN
OUT
MULTIPLEXER
RF PACKAGE "B"
"A" XMTR TEMP
20V COM
+20VDC
+28VDC
-28VDC
CKT TYP
+28VDC BUS "A"
PWR CONT BOX
28V COM
SPARE
TEMP SENSOR
RF XMTR (TXV)
RF INPUT
+28VDC
+200VDC
PWR RET
HTR RET
+28VDC (TXV100)
PWR RET
+28VDC
TXV PWR SUPPLY
6.3VAC TAV 100
PWR RET
+28VDC
TAV PWR

2

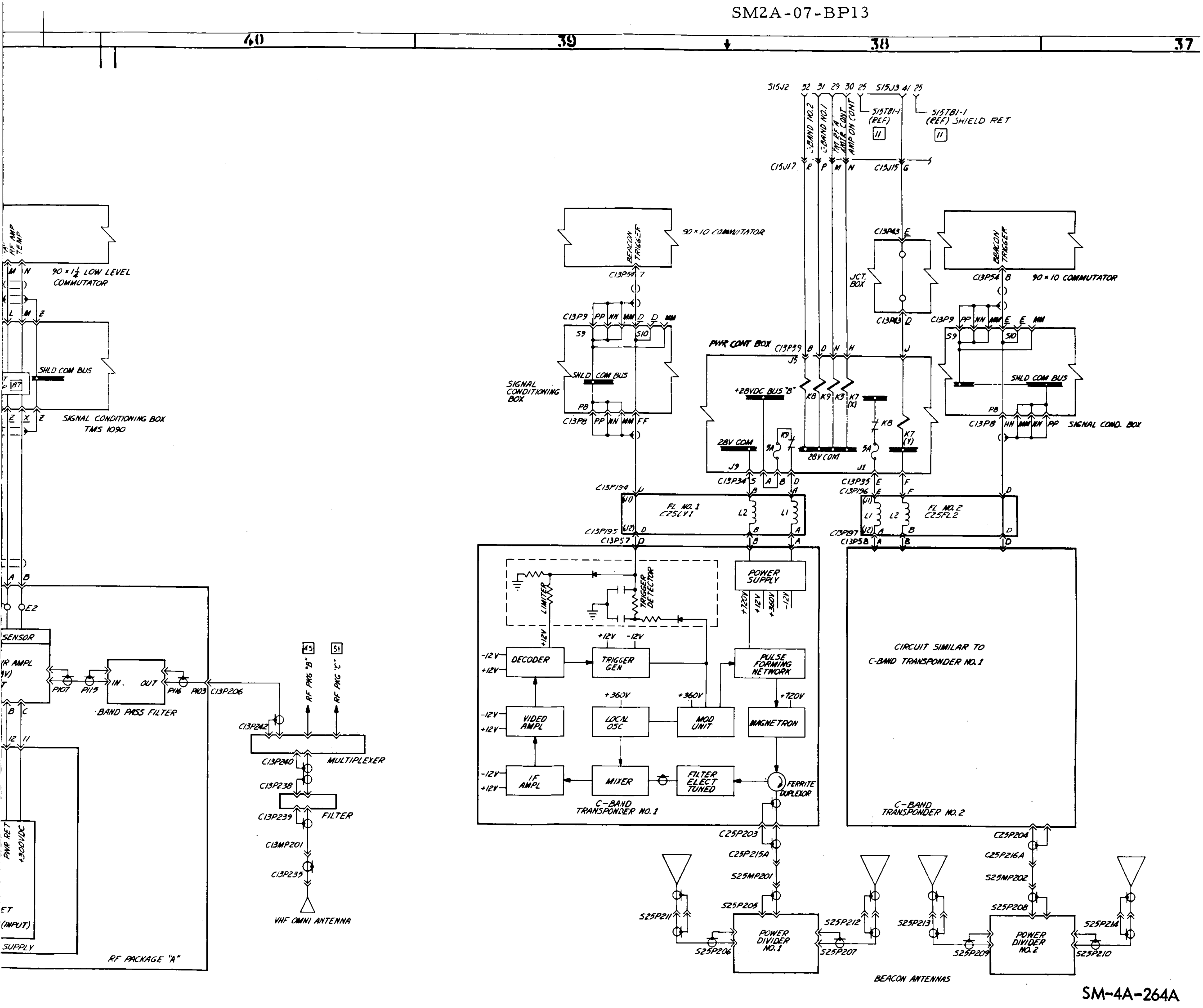
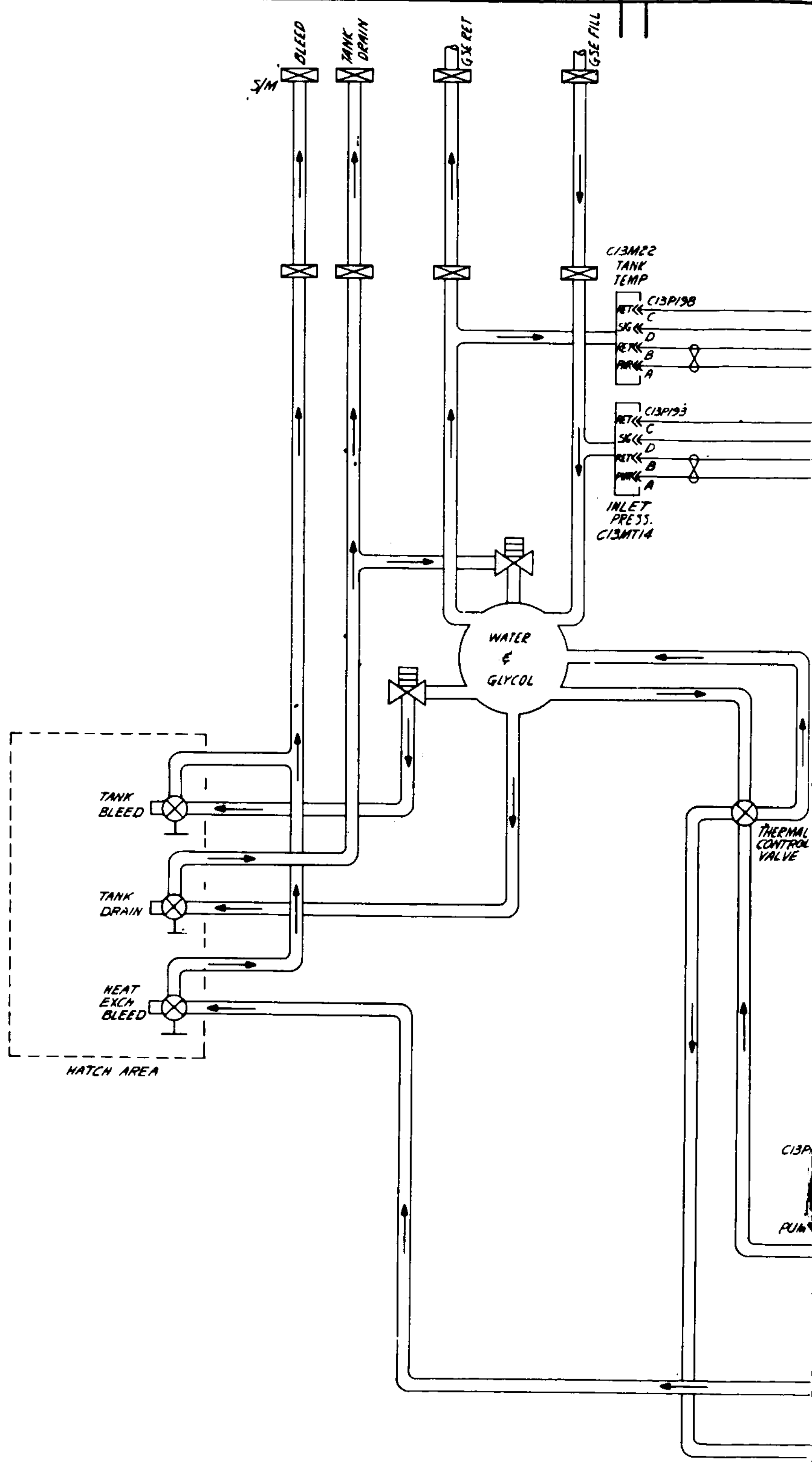


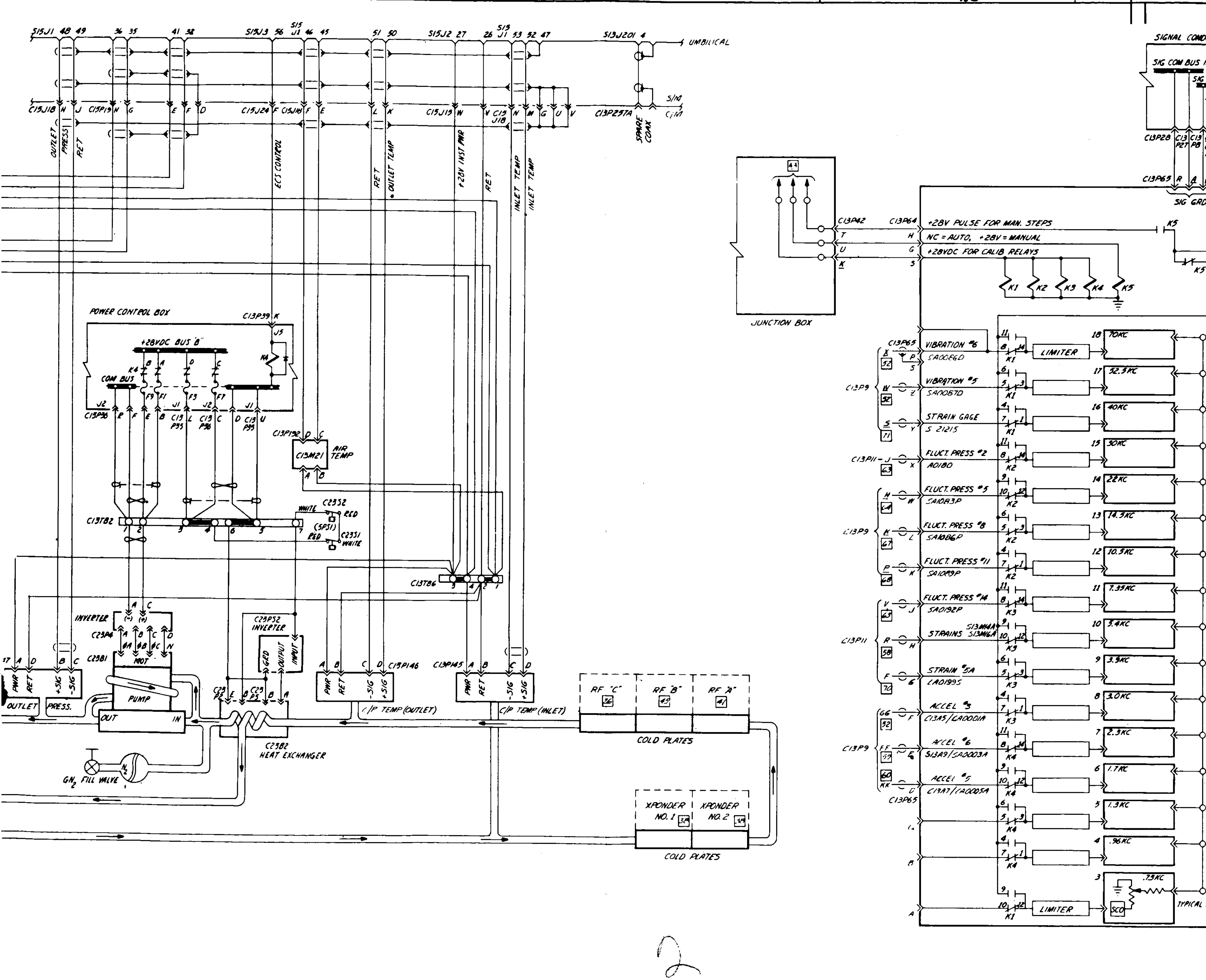

Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 5 of 8)

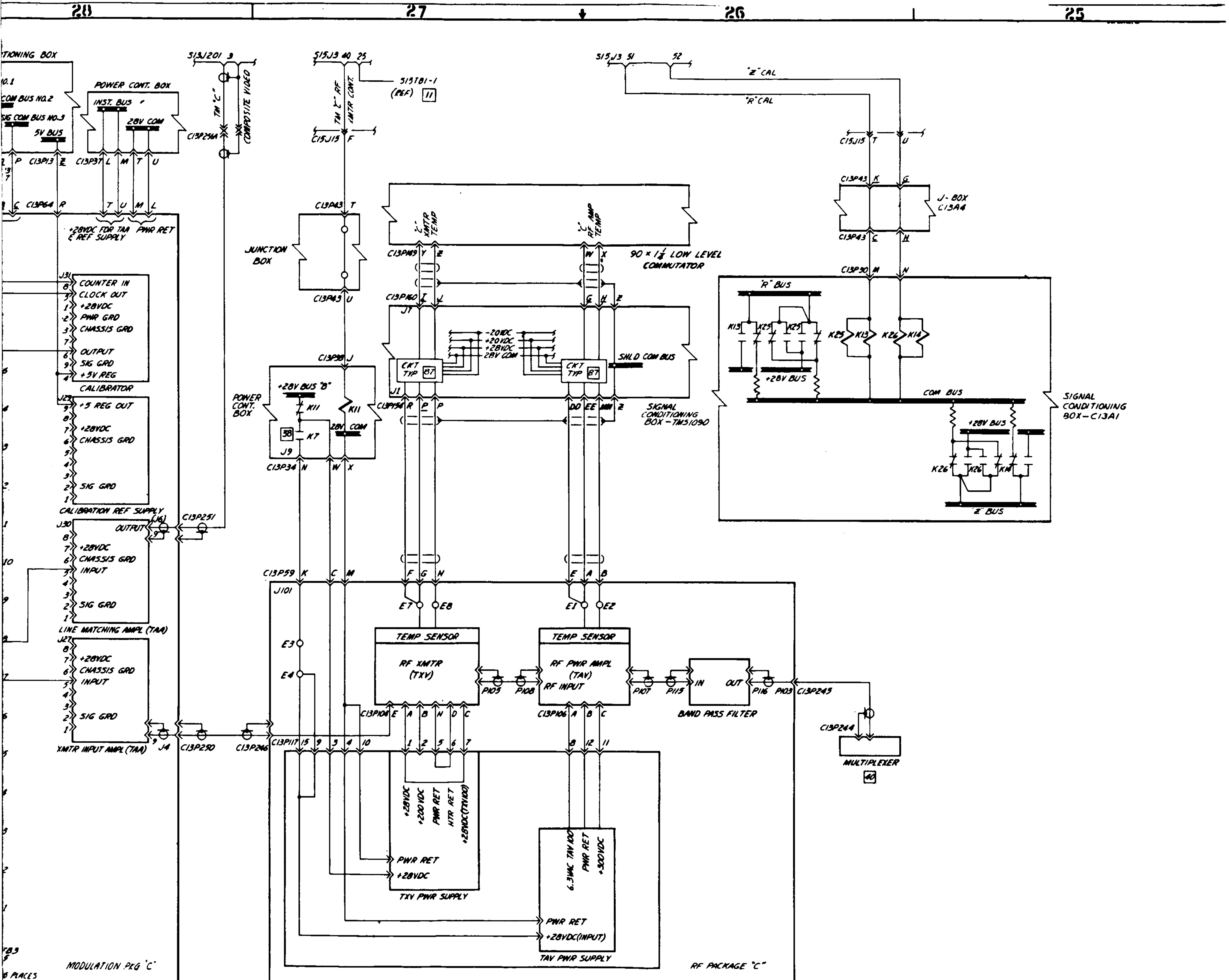
3

36 35 34 33



BLEED
S/M
TANK DRAIN
GSE RET
GSE FILL
C13M22
TANK TEMP
C13P198
RET
SIG
RET
PWR
C
D
B
A
C13P193
RET
SIG
RET
PWR
C
D
B
A
INLET PRESS.
C13MT14
WATER & GLYCOL
TANK BLEED
TANK DRAIN
HEAT EXCH BLEED
HATCH AREA
THERMAL CONTROL VALVE

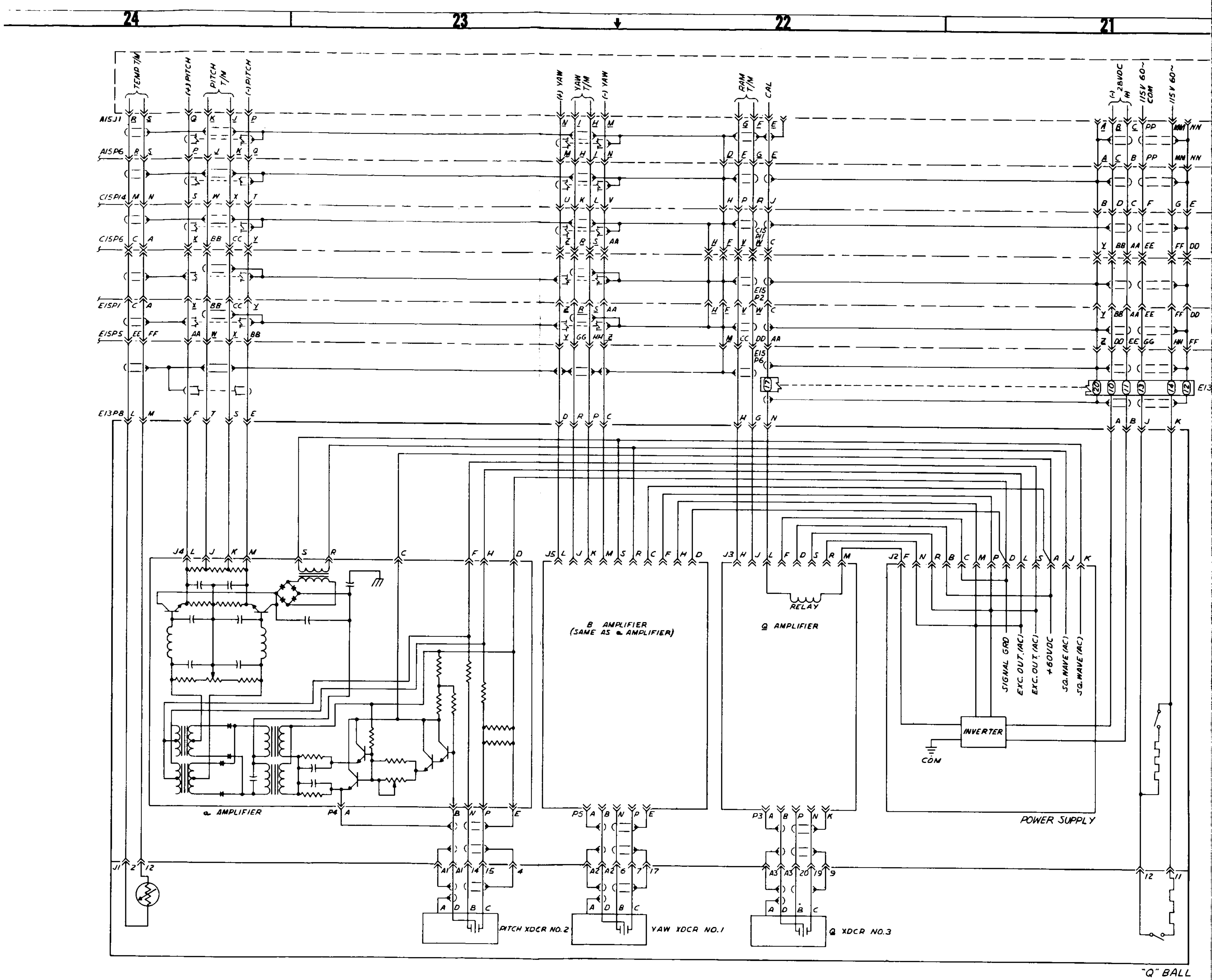

UMBILICAL
SPARE COAX
OUTLET PRESS
RET
ECS CONTROL
RET
OUTLET TEMP
+28V INST PWR
RET
INLET TEMP
INLET TEMP
JUNCTION BOX
POWER CONTROL BOX
+28VDC BUS "B"
COM BUS
AIR TEMP
C13TB2
C13TB6
INVERTER
C23P52 INVERTER
PUMP
OUTLET
PRESS.
GN2 FILL VALVE
C23B2 HEAT EXCHANGER
C/P TEMP (OUTLET)
C/P TEMP (INLET)
RF "C"
RF "B"
RF "A"
COLD PLATES
XPONDER NO. 1
XPONDER NO. 2
COLD PLATES
SIGNAL COND
SIG COM BUS
SIG GRD
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V = MANUAL
+28VDC FOR CALIB RELAYS
VIBRATION #6
SA0068D
VIBRATION #5
SA0067D
STRAIN GAGE
S 21215
FLUCT. PRESS #2
A0180
FLUCT. PRESS #5
SA1083P
FLUCT. PRESS #8
SA1086P
FLUCT. PRESS #11
SA1089P
FLUCT. PRESS #14
SA0192P
STRAINS S13M4A S13M6A
STRAIN #5A
CA0199S
ACCEL #3
C13A5/CA0001A
ACCEL #6
S13A9/SA0003A
ACCEL #5
C13A7/CA0005A
LIMITER
70KC
52.5KC
40KC
30KC
22KC
14.5KC
10.5KC
7.35KC
5.4KC
3.9KC
3.0KC
2.3KC
1.7KC
1.3KC
.96KC
.73KC
SCO
TYPICAL

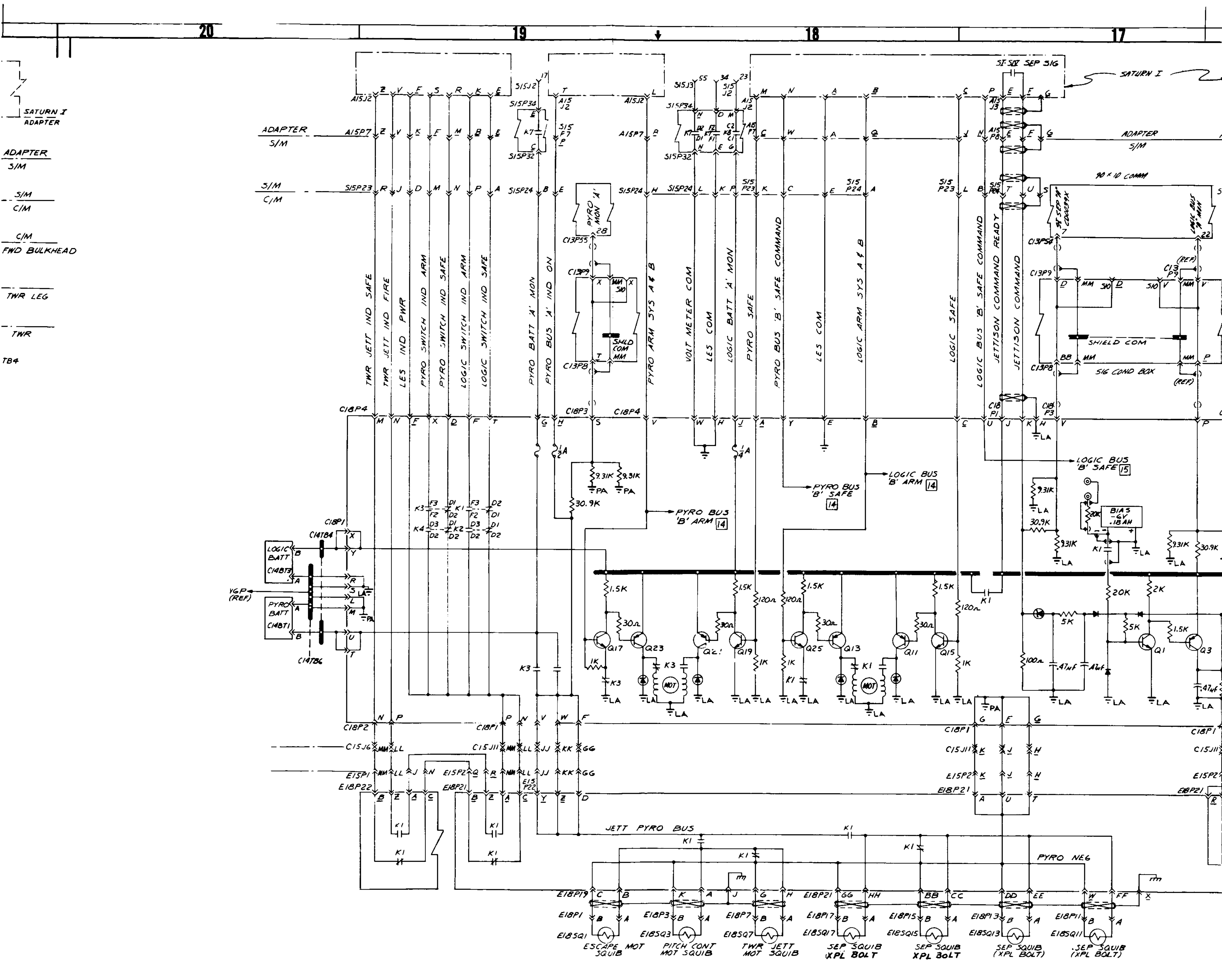



SM-4A-265A

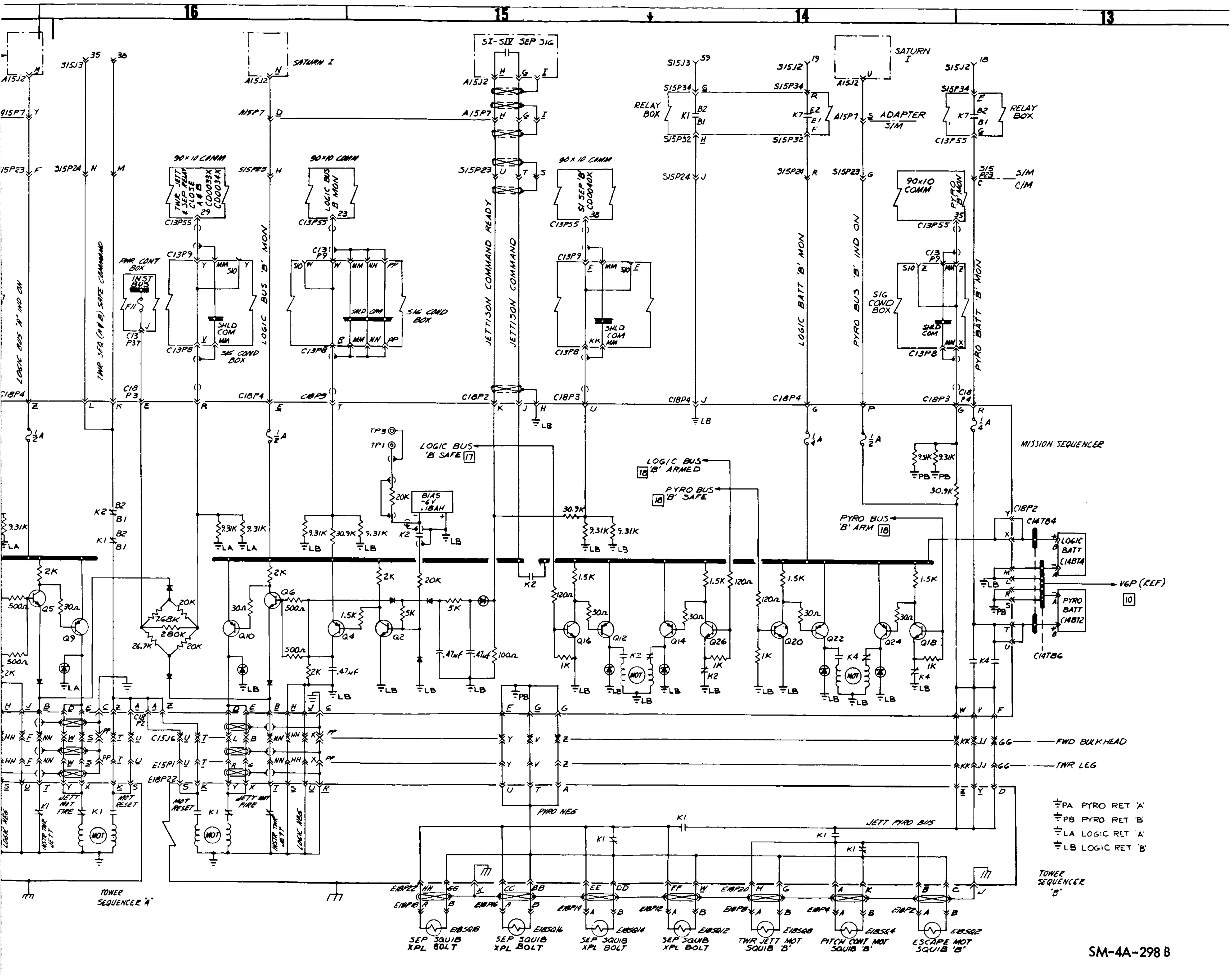
Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 6 of 8)

3


24
23
22
21
TEMP T/M
(+) PITCH
PITCH T/M
(-) PITCH
(+) YAW
YAW T/M
(-) YAW
RAM T/M
CAL
(+) 28VDC
115V 60~ COM
115V 60~
A15J1
A15P6
C15P14
C15P6
E15P1
E15P5
E13P8
J4
J5
J3
J2
B AMPLIFIER (SAME AS α AMPLIFIER)
Q AMPLIFIER
RELAY
SIGNAL GRD
EXC. OUT. (AC)
EXC. OUT. (AC)
+60VDC
SQ. WAVE (AC)
SQ. WAVE (AC)
INVERTER
COM
α AMPLIFIER
P4
P5
P3
POWER SUPPLY
PITCH XDCR NO. 2
YAW XDCR NO. 1
Q XDCR NO. 3
"Q" BALL


20
19
18
17
SATURN I
ADAPTER
S/M
C/M
FWD BULKHEAD
TWR LEG
TWR
TB4
TWR JETT IND SAFE
TWR JETT IND FIRE
LES IND PWR
PYRO SWITCH IND ARM
PYRO SWITCH IND SAFE
LOGIC SWITCH IND ARM
LOGIC SWITCH IND SAFE
PYRO BATT 'A' MON
PYRO BUS 'A' IND ON
PYRO ARM SYS A & B
VOLT METER COM
LES COM
LOGIC BATT 'A' MON
PYRO SAFE
PYRO BUS 'B' SAFE COMMAND
LOGIC ARM SYS A & B
LOGIC SAFE
LOGIC BUS 'B' SAFE COMMAND
JETTISON COMMAND READY
JETTISON COMMAND
PYRO MON 'A'
SHLD COM MM
SHIELD COM
S16 COND BOX
90 × 10 COMM
PYRO BUS 'B' ARM 14
PYRO BUS 'B' SAFE 14
LOGIC BUS 'B' ARM 14
LOGIC BUS 'B' SAFE 15
BIAS 6V .18AH
LOGIC BATT C14BT3
PYRO BATT C14BT1
YGP (REF)
JETT PYRO BUS
PYRO NEG
ESCAPE MOT SQUIB
PITCH CONT MOT SQUIB
TWR JETT MOT SQUIB
SEP SQUIB XPL BOLT
SEP SQUIB XPL BOLT
SEP SQUIB (XPL BOLT)
SEP SQUIB (XPL BOLT)

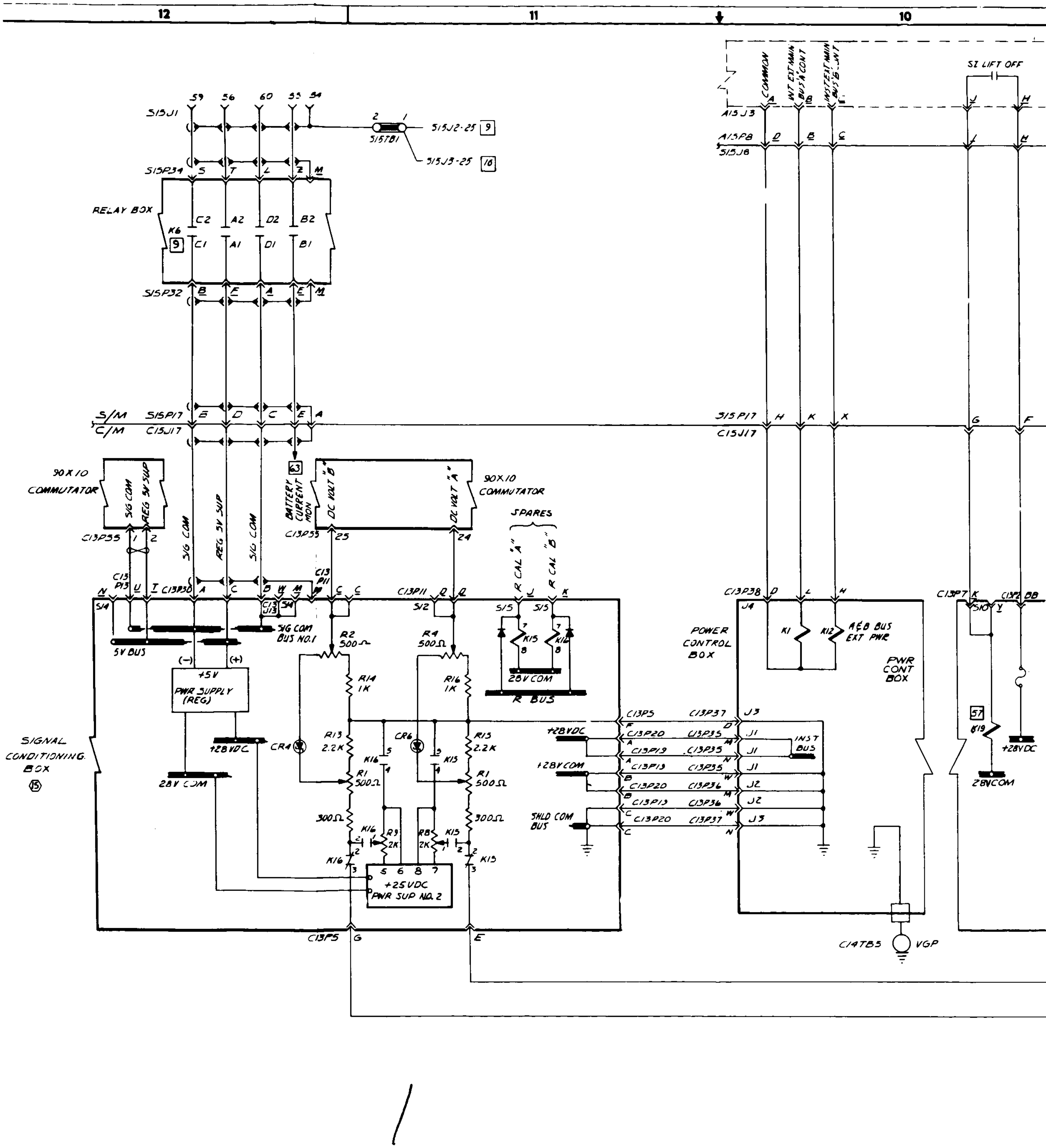
2



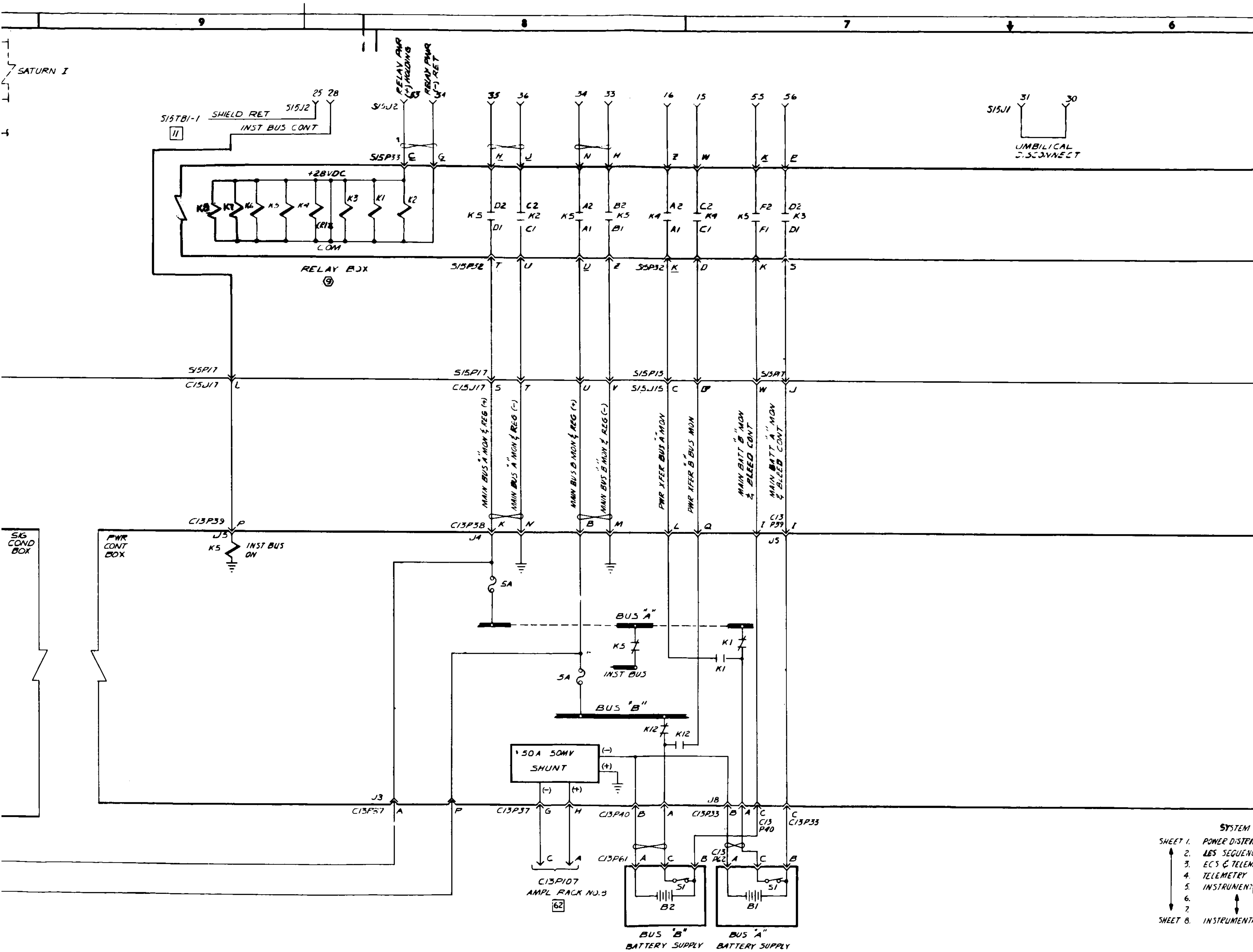
SM-4A-298 B

Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg B) (Sheet 7 of 8)

3

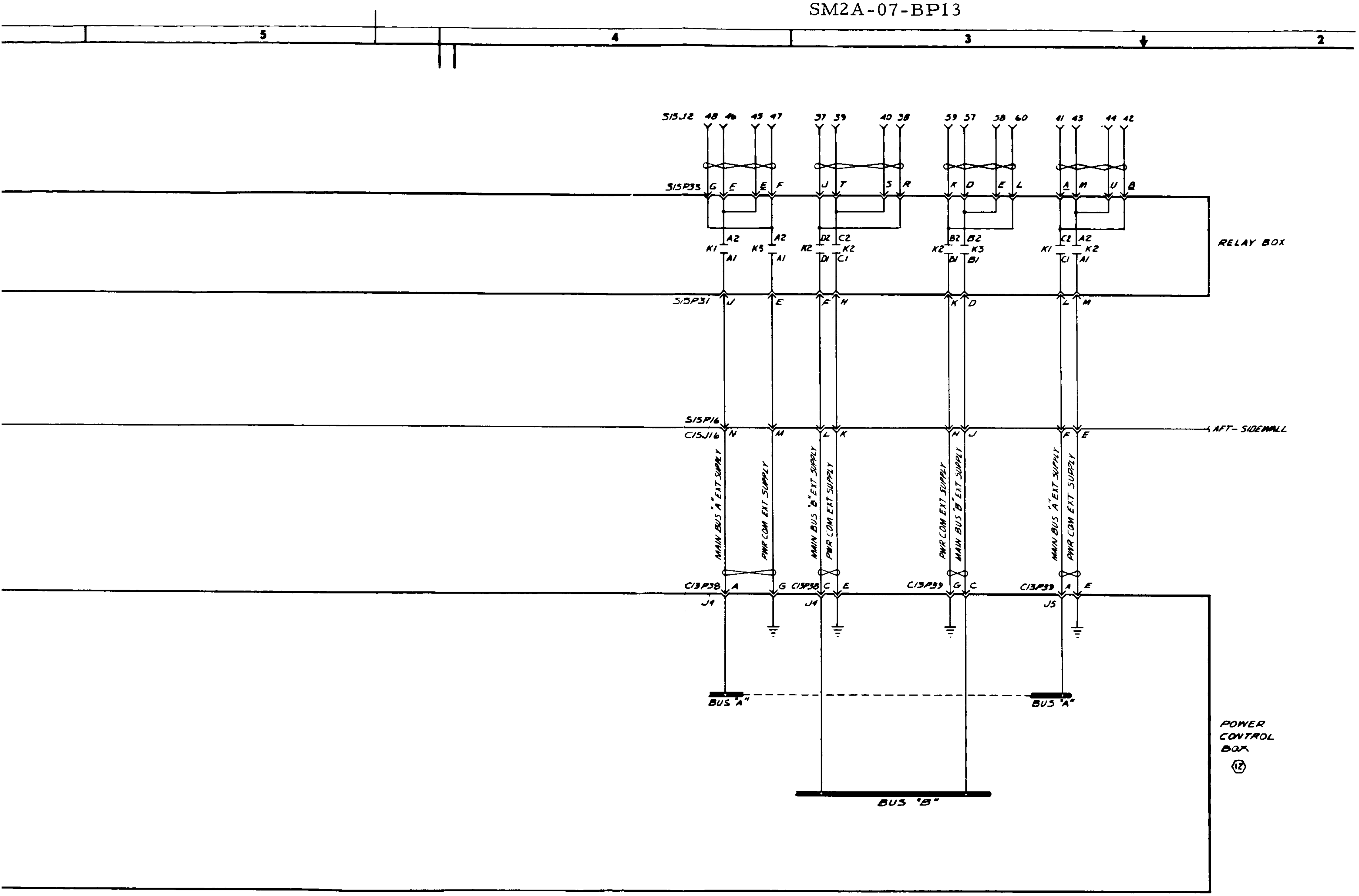


12
11
10
RELAY BOX
SIGNAL CONDITIONING BOX
POWER CONTROL BOX
PWR CONT BOX
90X10 COMMUTATOR
SPARES
SI LIFT OFF
+5V PWR SUPPLY (REG)
+25VDC PWR SUP NO. 2
5V BUS
SIG COM BUS NO.1
28V COM
R BUS
SHLD COM BUS
INST BUS
A&B BUS EXT PWR
BATTERY CURRENT MON
DC VOLT "B"
DC VOLT "A"
R CAL "A"
R CAL "B"
C14TB5
VGP



9
8
7
6
SATURN I
S15TB1-1
SHIELD RET
S15J2
INST BUS CONT
RELAY PWR (+) HOLDING
RELAY PWR (-) RET
S15J2
S15P33
+28VDC
COM
RELAY BOX
S15P32
S15P17
C15J17
S15P15
S15J15
MAIN BUS "A" MON & REG (+)
MAIN BUS "A" MON & REG (-)
MAIN BUS B MON & REG (+)
MAIN BUS "B" MON & REG (-)
PWR XFER BUS "A" MON
PWR XFER "B" BUS MON
MAIN BATT "B" MON & BLEED CONT
MAIN BATT "A" MON & BLEED CONT
S15J1
UMBILICAL DISCONNECT
C13P39
C13P38
SIG COND BOX
PWR CONT BOX
INST BUS ON
BUS "A"
INST BUS
BUS "B"
50A 50MV SHUNT
C13P37
C13P40
C13P33
C13P61
C13P62
C13P107
AMPL RACK NO.5
B2
B1
BUS "B" BATTERY SUPPLY
BUS "A" BATTERY SUPPLY
SYSTEM
SHEET 1. POWER DISTR
2. LES SEQUENC
3. ECS & TELEM
4. TELEMETRY
5. INSTRUMENT
6.
7.
SHEET 8. INSTRUMENT


2




NDEX
ITION
ER
TRY

ION (ACCEL, VIB AMPL & STRAIN GA).
(FLUCT PRESS., INT PRESS XDUCER & STRAIN GA).
(CALORIMETER & ZONE BOX).
TION (CALORIMETER, RES THERM, INT TEMP & ZONE BOX).

17 FOR WIRING DIAG TWR SEQUENCER SEE B15-945901.
16 SEQUENCER SEE B16-450220.
15 SC BOX SEE NASA DWG SX530060
14 J-BOX SEE NASA DWG SC530013.
13 RF PKG SEE NASA DWG SD530136
12 PCB SEE NASA DWG SX540007.
11 SEE B16-450210.
10 RELAY BOX SEE B16-450208.
9 RELAY BOX SEE B17-450221.
8 SEE B17-450208.
7 FOR WIRING DIAG SEE B18-450201.
6 FOR SCHEM DIAG PCB SEE NASA DWG SX530170.
5 ACCEL SB530010.
4 VIB AMPL SC510063.
3 FLUCT PRESS SB530016.
2 ZONE BOX SC550008.
1 FOR SCHEM DIAG STRAIN GAUGE SEE NASA DWG SB530017.

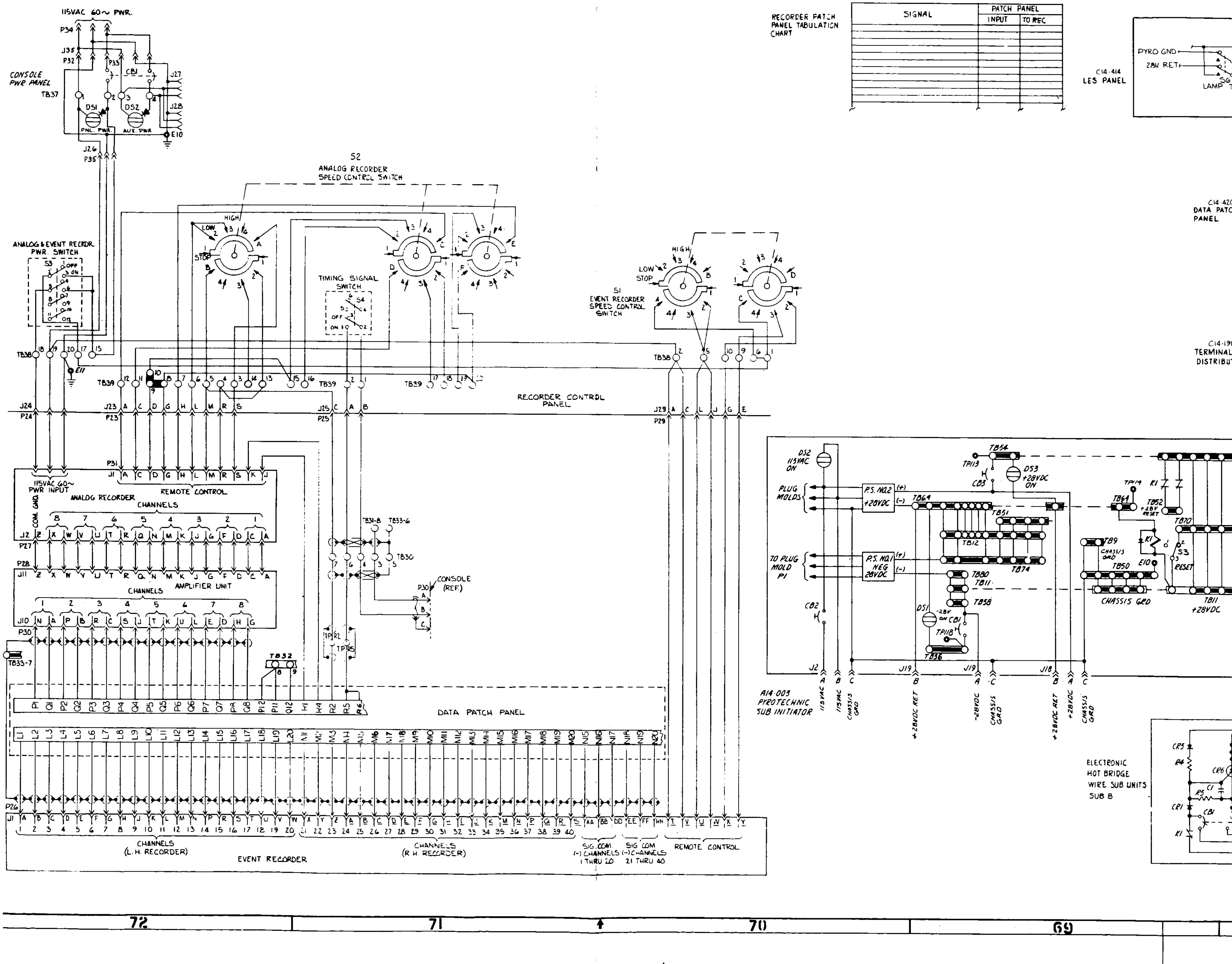
NOTES: UNLESS OTHERWISE SPECIFIED.

24. FOR GSE & SPACECRAFT GROUNDING SCHEMATIC SEE B14-900105.
23. FOR CABLING DIAGRAM SEE B14-900104.
22. FOR MATING GSE INTERGRATED SCHEMATIC SEE G14-900004
21. ALL RELAYS ARE SHOWN IN THE UNENERGIZED POSITION.
20. UNDERLINED LETTERS DENOTE LOWER CASE.
19 FOR SCHEM DIAG MOD B & C SEE NASA DWG SX530097.
18 FOR SCHEM DIAG MOD A SEE NASA DWG SX530135

SM-4A-267C

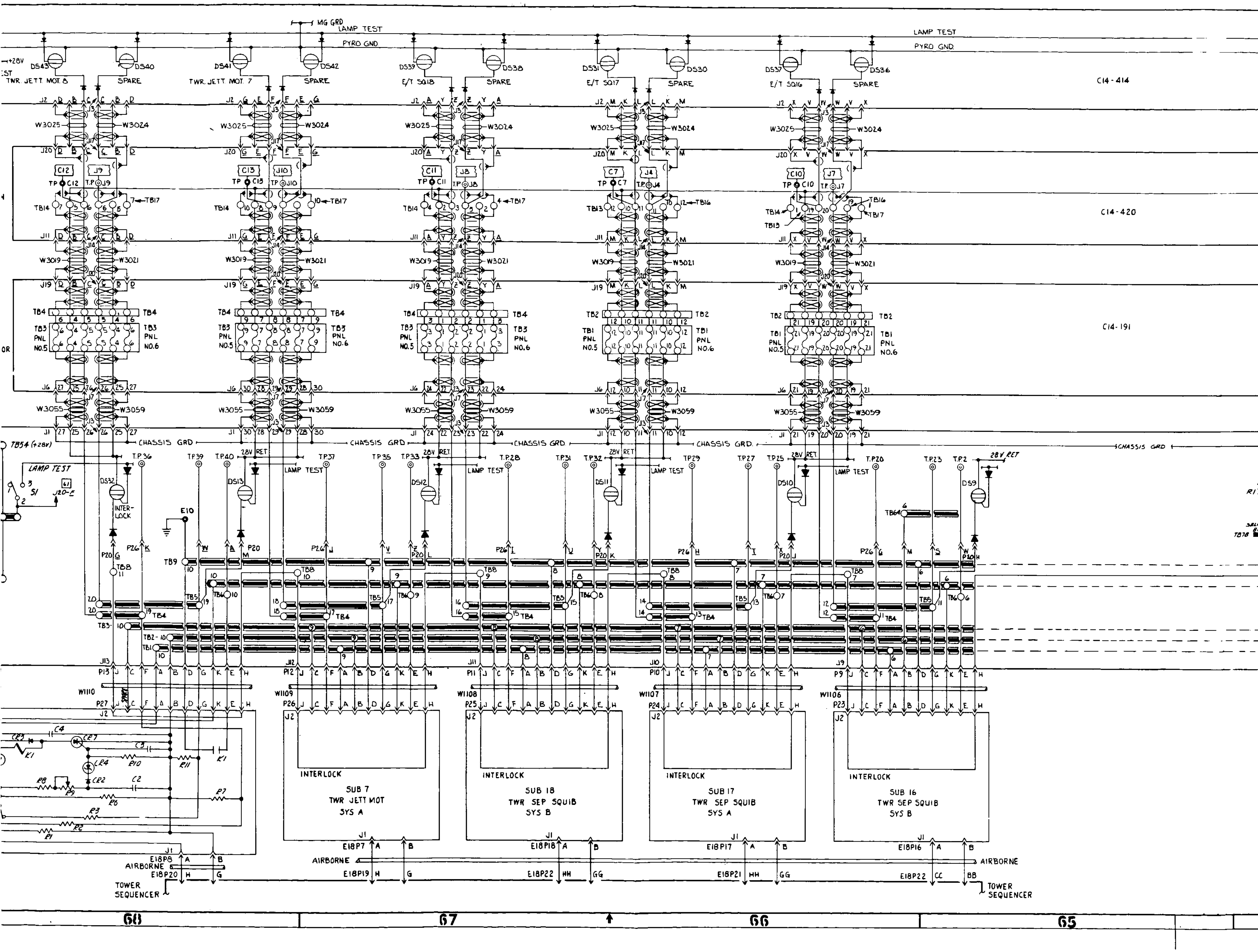
Figure 8-1. Boilerplate 13 Combined Systems Schematic
(Dwg B14-90004, Chg C) (Sheet 8 of 8)

3




RECORDER PATCH PANEL TABULATION CHART

| SIGNAL | PATCH PANEL INPUT | PATCH PANEL TO REC |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |


MG GRD
LAMP TEST
PYRO GND
TWR JETT MOT 8
SPARE
TWR JETT MOT 7
E/T SQ18
E/T SQ17
E/T SQ16
W3025
W3024
W3019
W3021
W3055
W3059
C14-414
C14-420
C14-191
TB3 PNL NO.5
TB3 PNL NO.6
TB1 PNL NO.5
TB1 PNL NO.6
CHASSIS GRD
28V RET
LAMP TEST
INTER-LOCK
INTERLOCK
SUB 7
TWR JETT MOT
SYS A
SUB 18
TWR SEP SQUIB
SYS B
SUB 17
TWR SEP SQUIB
SYS A
SUB 16
TWR SEP SQUIB
SYS B
AIRBORNE
TOWER SEQUENCER
68
67
66
65

2

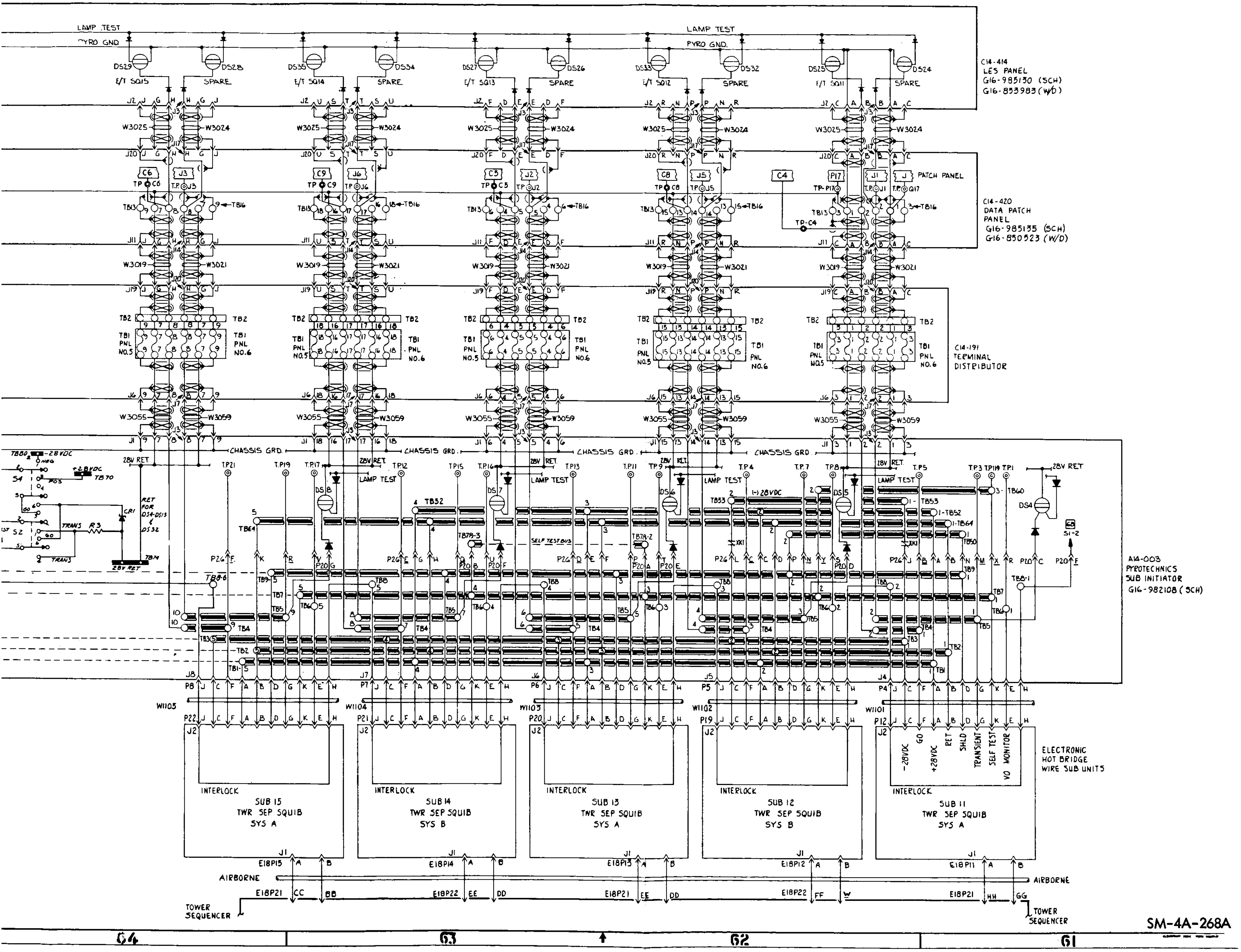
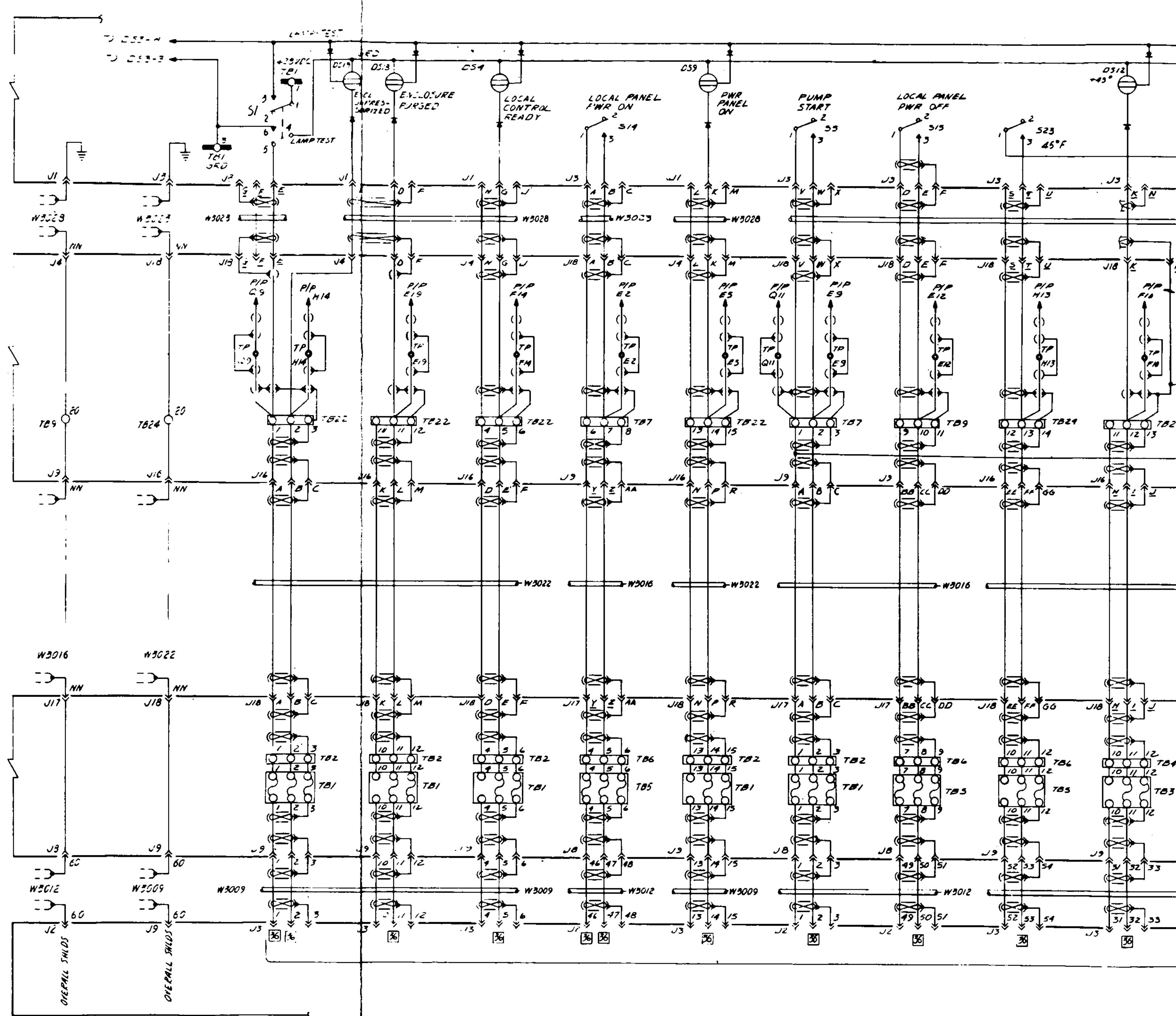
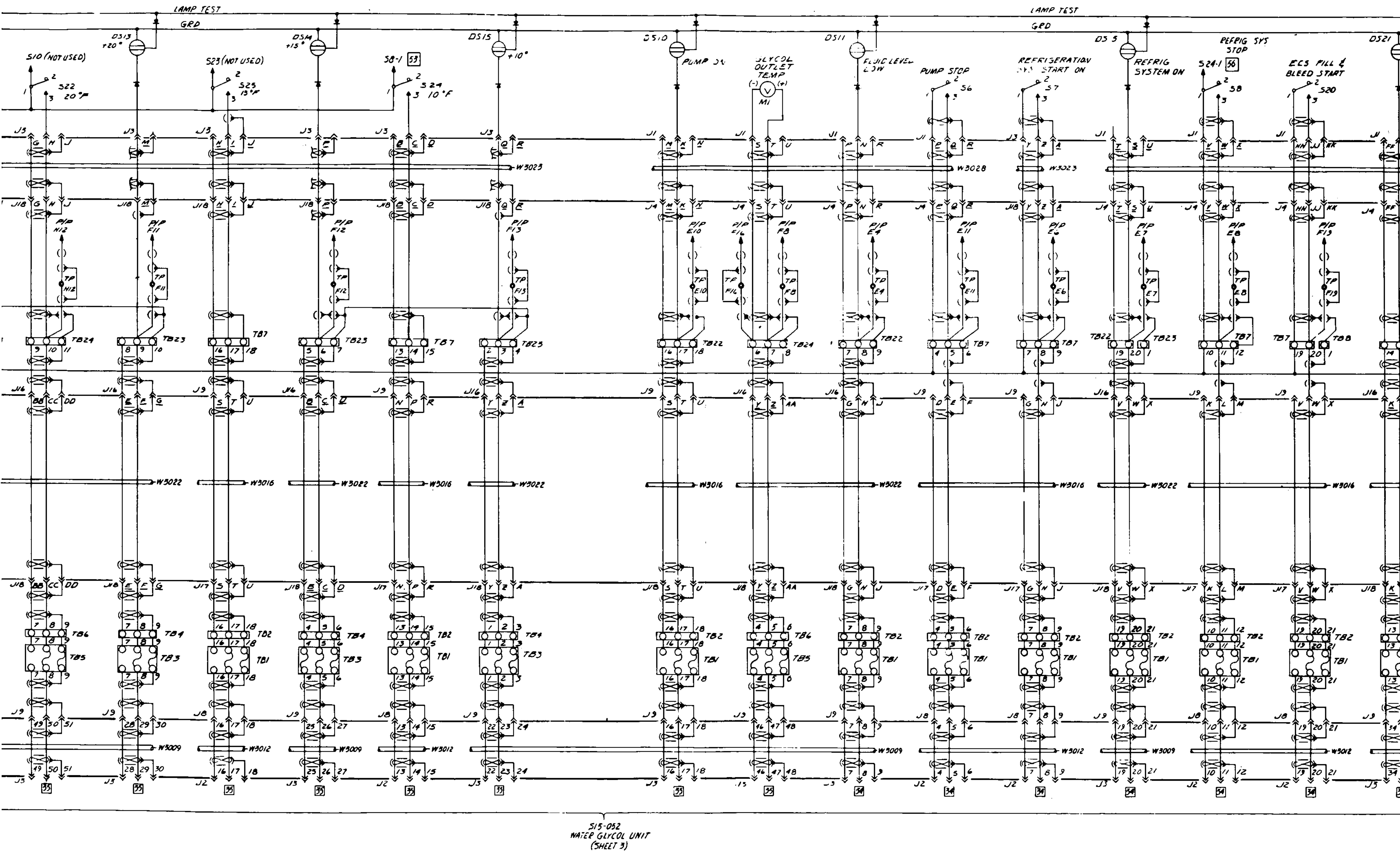



Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004)
(Sheet 1 of 6)

3


LAMP TEST
S1
ENCLOSURE PURGED
LOCAL CONTROL READY
LOCAL PANEL PWR ON
S14
PWR PANEL ON
PUMP START
LOCAL PANEL PWR OFF
S15
S23
45°F
W3028
W3023
W3016
W3022
W3012
W3009
TB1
TB2
TB3
TB4
TB5
TB6
TB7
TB9
TB22
TB24
OVERALL SHLDS

60 59 58 57


LAMP TEST
GRD
S10 (NOT USED)
S22 20°F
DS13 +20°
S23 (NOT USED)
S25 15°F
DS14 +15°
S8-1 53
S24 10°F
DS15 +10°
DS10
GLYCOL OUTLET TEMP
M1
DS11
FLUID LEVEL LOW
PUMP STOP
S6
REFRIGERATION SYS START ON
S7
DS5
REFRIG SYSTEM ON
REFRIG SYS STOP
S24-1 56
S8
ECS FILL & BLEED START
S20
DS21
W3023
W3028
W3022
W3016
W3009
W3012
515-052
WATER GLYCOL UNIT
(SHEET 3)

56 55 54 53

2

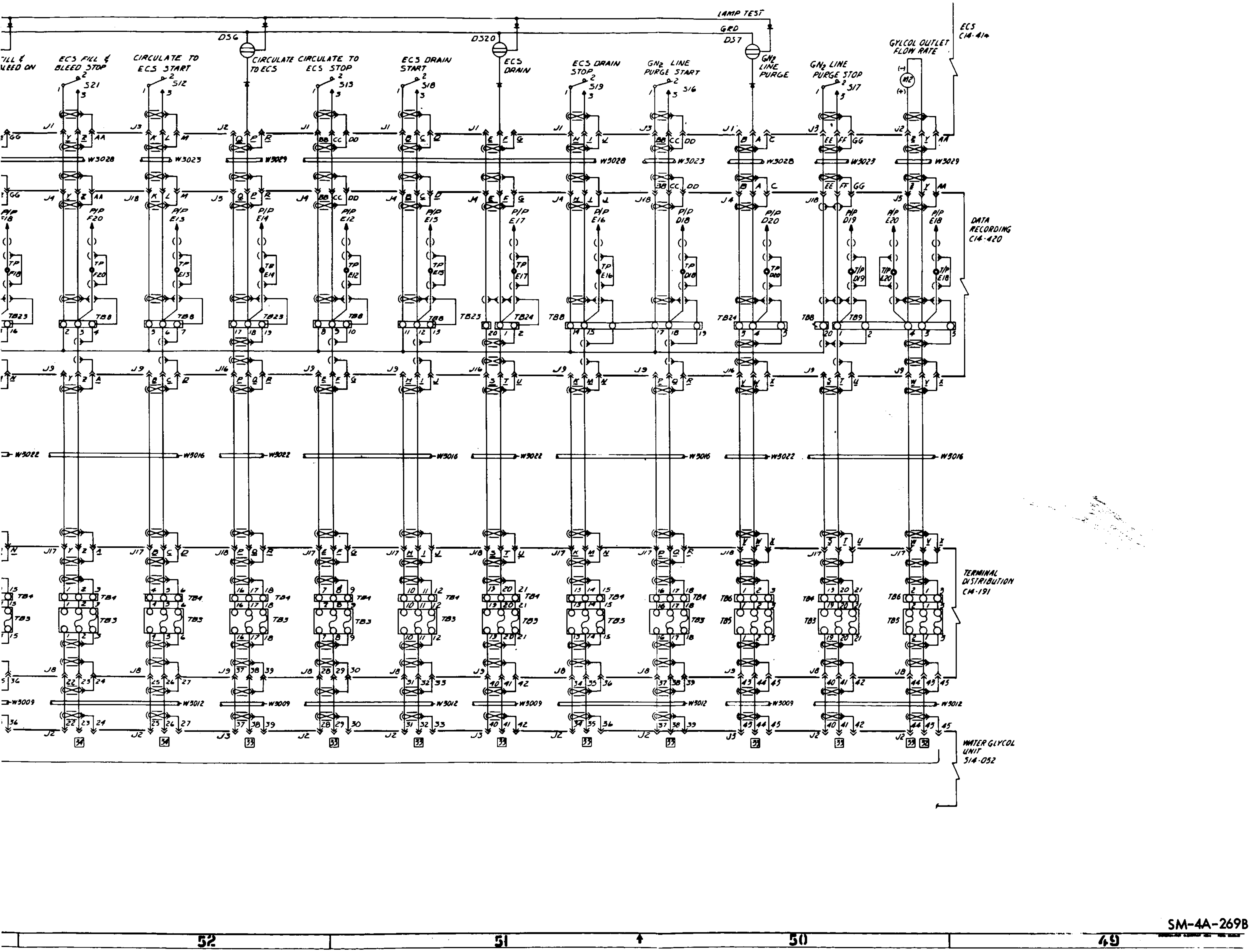
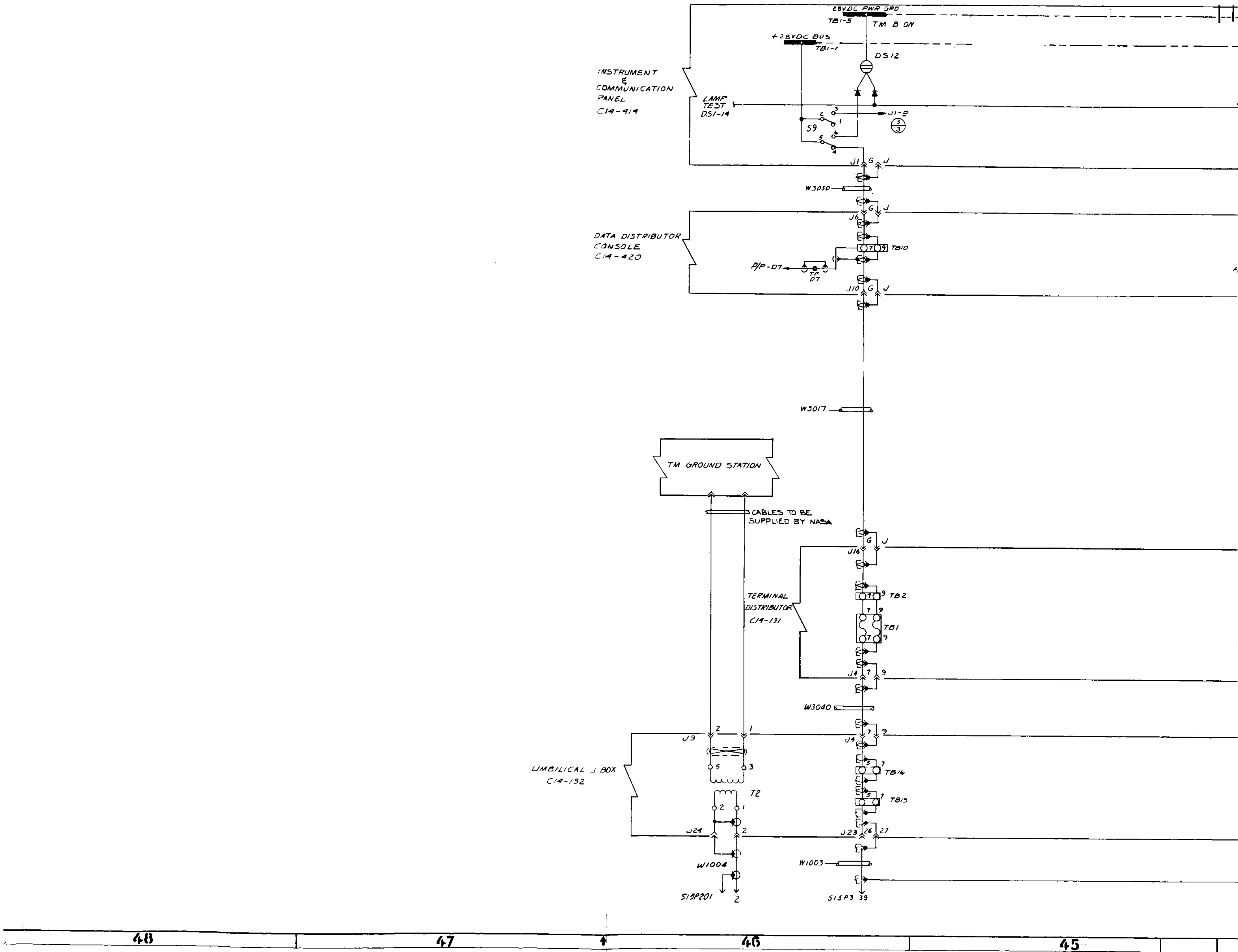
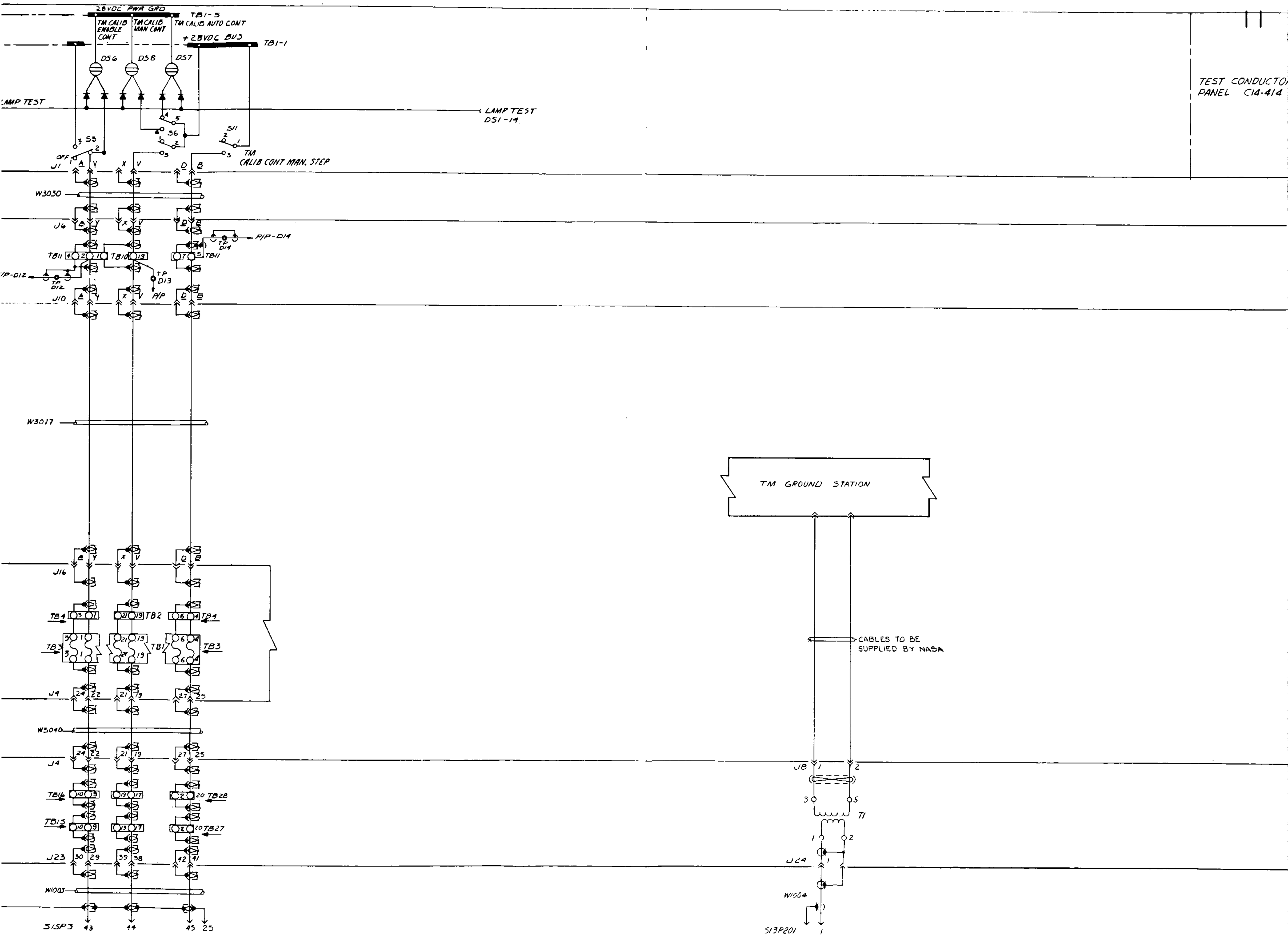



Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004) (Sheet 2 of 6)

3


28VDC PWR GRD
TB1-5
TM B ON
+28VDC BUS
TB1-1
DS12
INSTRUMENT & COMMUNICATION PANEL
C14-419
LAMP TEST
DS1-14
S9
J1-B
J1
G
J
W3030
J6
DATA DISTRIBUTOR CONSOLE
C14-420
TB10
P/P-D7
TP D7
J10
W3017
TM GROUND STATION
CABLES TO BE SUPPLIED BY NASA
J16
TERMINAL DISTRIBUTOR
C14-131
TB2
TB1
J4
W3040
J9
UMBILICAL J BOX
C14-192
T2
J24
W1004
S15P201
TB16
TB15
J23
W1003
S15P3 39
48
47
46
45



28VDC PWR GRD
TB1-5
TM CALIB ENABLE CONT
TM CALIB MAN CONT
TM CALIB AUTO CONT
+28VDC BUS
TB1-1
DS6
DS8
DS7
LAMP TEST
LAMP TEST DS1-14
S6
S11
S5
OFF
TM CALIB CONT MAN. STEP
TEST CONDUCTOR PANEL C14-414
J1
W3030
J6
TB11
TB10
P/P-D14
P/P-D12
TP D12
TP D13
TP D14
J10
W3017
TM GROUND STATION
J16
TB4
TB2
TB3
TB1
J4
W3040
CABLES TO BE SUPPLIED BY NASA
J8
T1
TB16
TB28
TB15
TB27
J23
J24
W1003
W1004
S15P3
S13P201


44 | 43 | 42 | 41

2

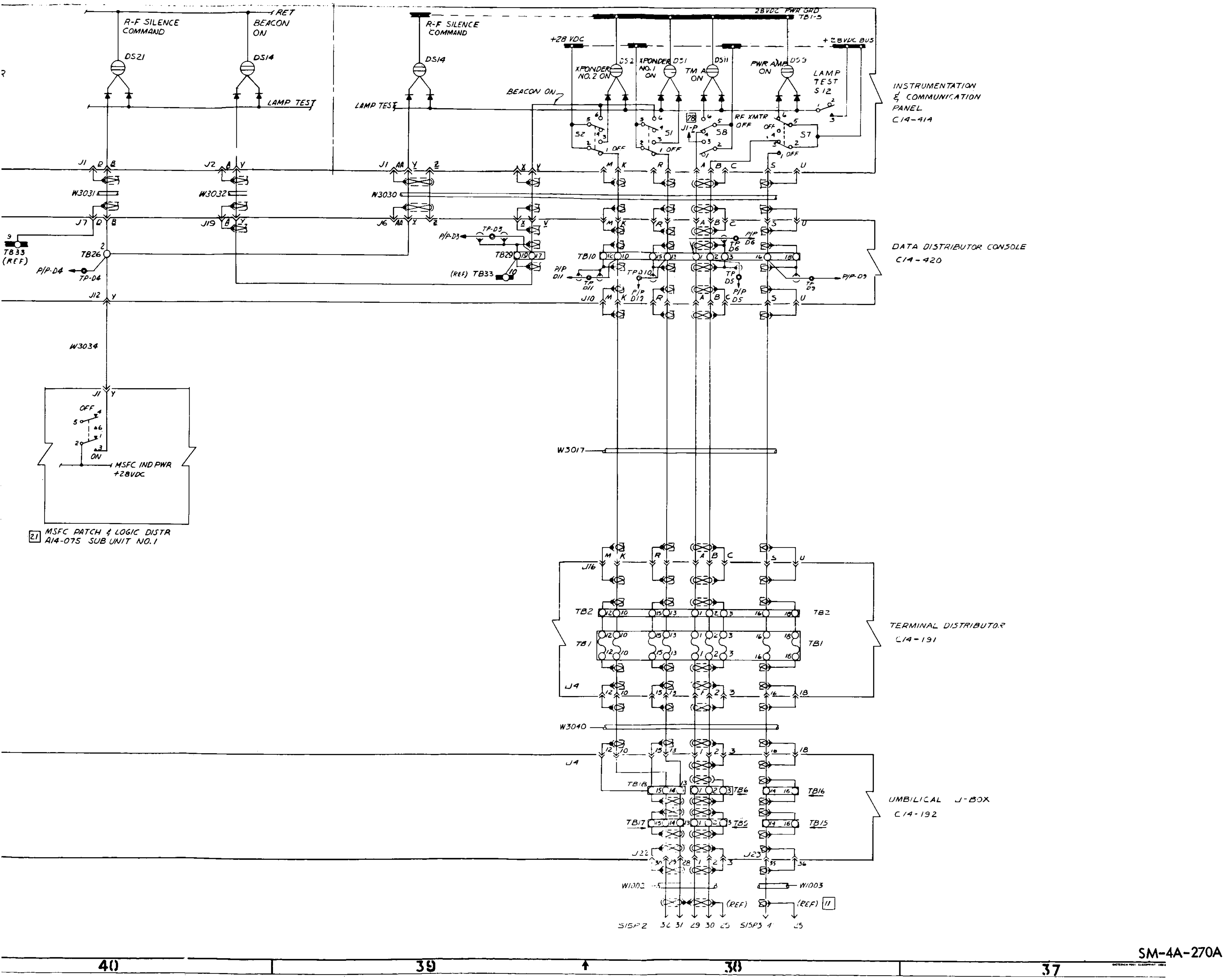
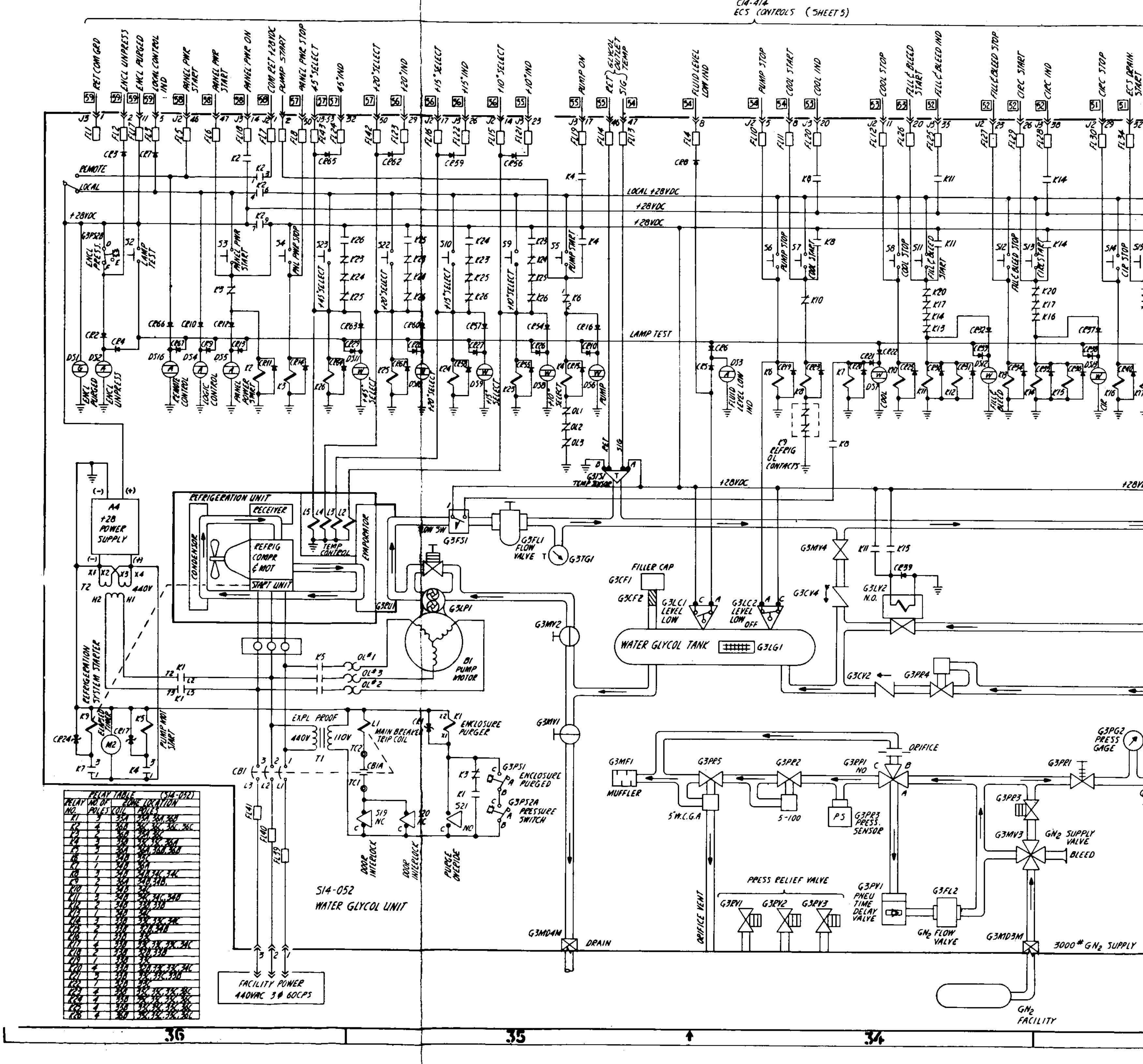
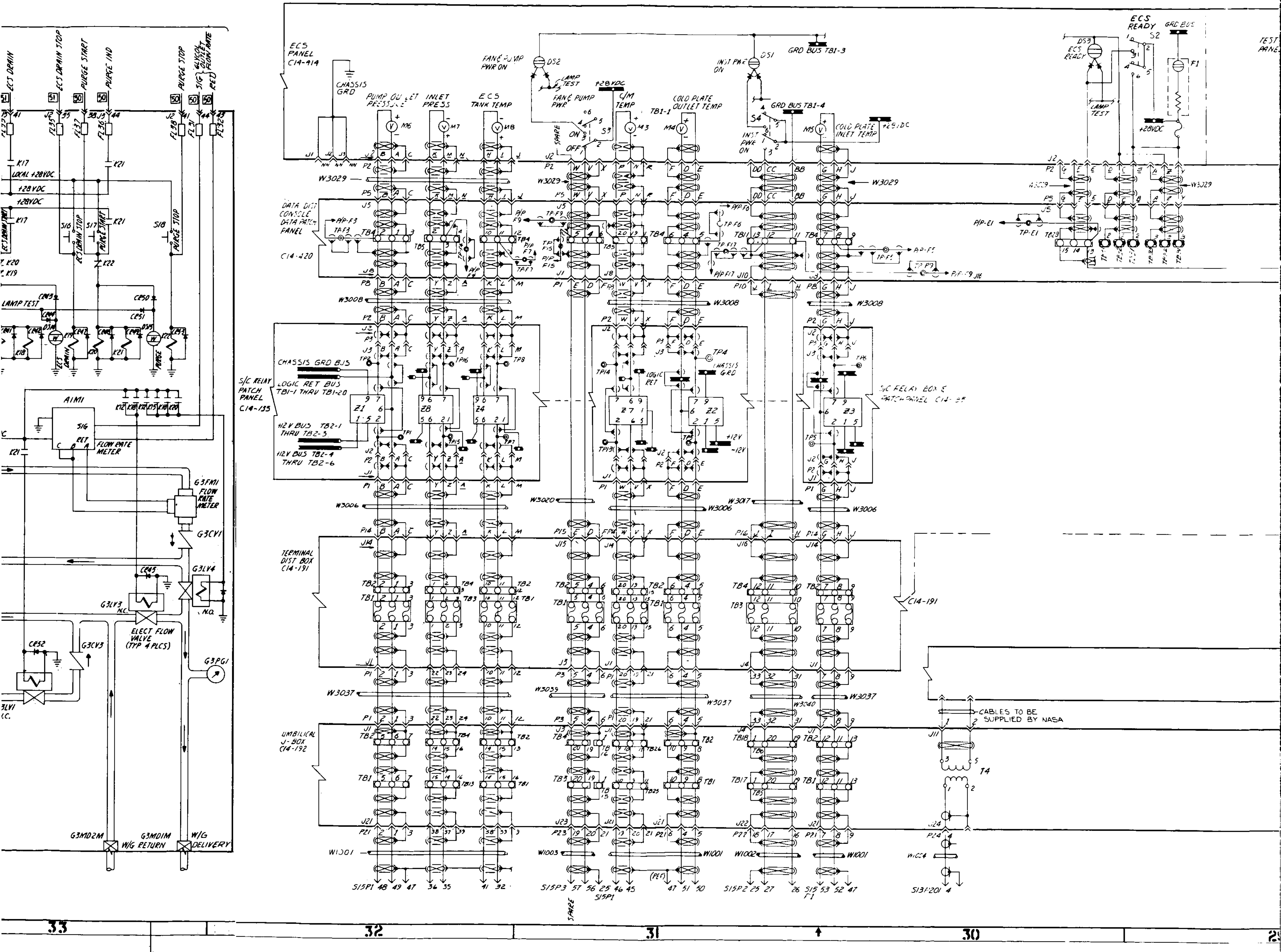



Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004) (Sheet 3 of 6)

3




| RELAY TABLE | | (S14-052) | |
|---|---|---|---|
| RELAY NO. | NO. OF POLES | ZONE LOCATION COIL | POLES |
| K1 | 3 | 35A | 35A,36A,36B |
| K2 | 4 | 36B | 36C,35C,36C,36C |
| K3 | 2 | 36B | 34A,36C |
| K4 | 3 | 35B | 35C,35C,36A |
| K5 | 3 | 36A | 36A,36A,36B |
| K6 | 1 | 34B | 35C |
| K7 | 1 | 34B | 36A |
| K8 | 3 | 34B | 34B,34C,34C |
| K9 | 2 | 36A | 34B,34B |
| K10 | 1 | 34B | 35C |
| K11 | 3 | 34B | 34C,34C,34B |
| K12 | 2 | 34B | 33B,33B |
| K13 | 1 | 34B | 34C |
| K14 | 3 | 33B | 33C,33C,34C |
| K15 | 2 | 33B | 34B,34B |
| K16 | 1 | 33B | 33C |
| K17 | 4 | 33B | 33C,33C,33C,34C |
| K18 | 2 | 33B | 33B,33B |
| K19 | 1 | 33B | 33C |
| K20 | 4 | 33B | 34B,33C,33C,34C |
| K21 | 3 | 33B | 33C,33C,33B |
| K22 | 1 | 33B | 33C |
| K23 | 4 | 35B | 35C,35C,35C,36C |
| K24 | 4 | 35B | 35C,35C,35C,36C |
| K25 | 4 | 35B | 35C,35C,35C,36C |
| K26 | 4 | 36A | 35C,35C,35C,36C |


ECS PANEL C14-414
CHASSIS GRD
PUMP OUTLET PRESSURE
INLET PRESS
ECS TANK TEMP
FAN & PUMP PWR ON
LAMP TEST
FAN & PUMP PWR
+28VDC
C/M TEMP
COLD PLATE OUTLET TEMP
INST PWR ON
GRD BUS TB1-3
GRD BUS TB1-4
COLD PLATE INLET TEMP
ECS READY
GRD BUS
TEST PANEL
ECS DRAIN
ECS DRAIN STOP
PURGE START
PURGE IND
PURGE STOP
GLYCOL FLOW RATE
LOCAL +28VDC
+28VDC
LAMP TEST
W3029
DATA DIST CONSOLE DATA PATCH PANEL C14-420
W3008
S/C RELAY PATCH PANEL C14-135
CHASSIS GRD BUS
LOGIC RET BUS TB1-1 THRU TB1-20
+12V BUS TB2-1 THRU TB2-3
-12V BUS TB2-4 THRU TB2-6
S/C RELAY BOX & PATCH PANEL C14-135
A1M1
FLOW RATE METER
G3FM1 FLOW RATE METER
G3CV1
G3LV4
N.O.
G3LV3 N.C.
ELECT FLOW VALVE (TYP 4 PLCS)
G3CV3
G3PG1
G3LV1 N.C.
W3006
W3020
W3017
TERMINAL DIST BOX C14-191
C14-191
W3037
W3039
W3040
CABLES TO BE SUPPLIED BY NASA
UMBILICAL J-BOX C14-192
T4
G3MD2M W/G RETURN
G3MD1M W/G DELIVERY
W1001
W1003
W1002
W1004
S15P1 48 49 47
36 35
41 32
S15P3 57 56 25 46 45
S15P1
SPARE
(PLF)
47 51 50
S15P2 25 27
26
S15 53 52 47 P1
S13P201 4
33
32
31
30

2

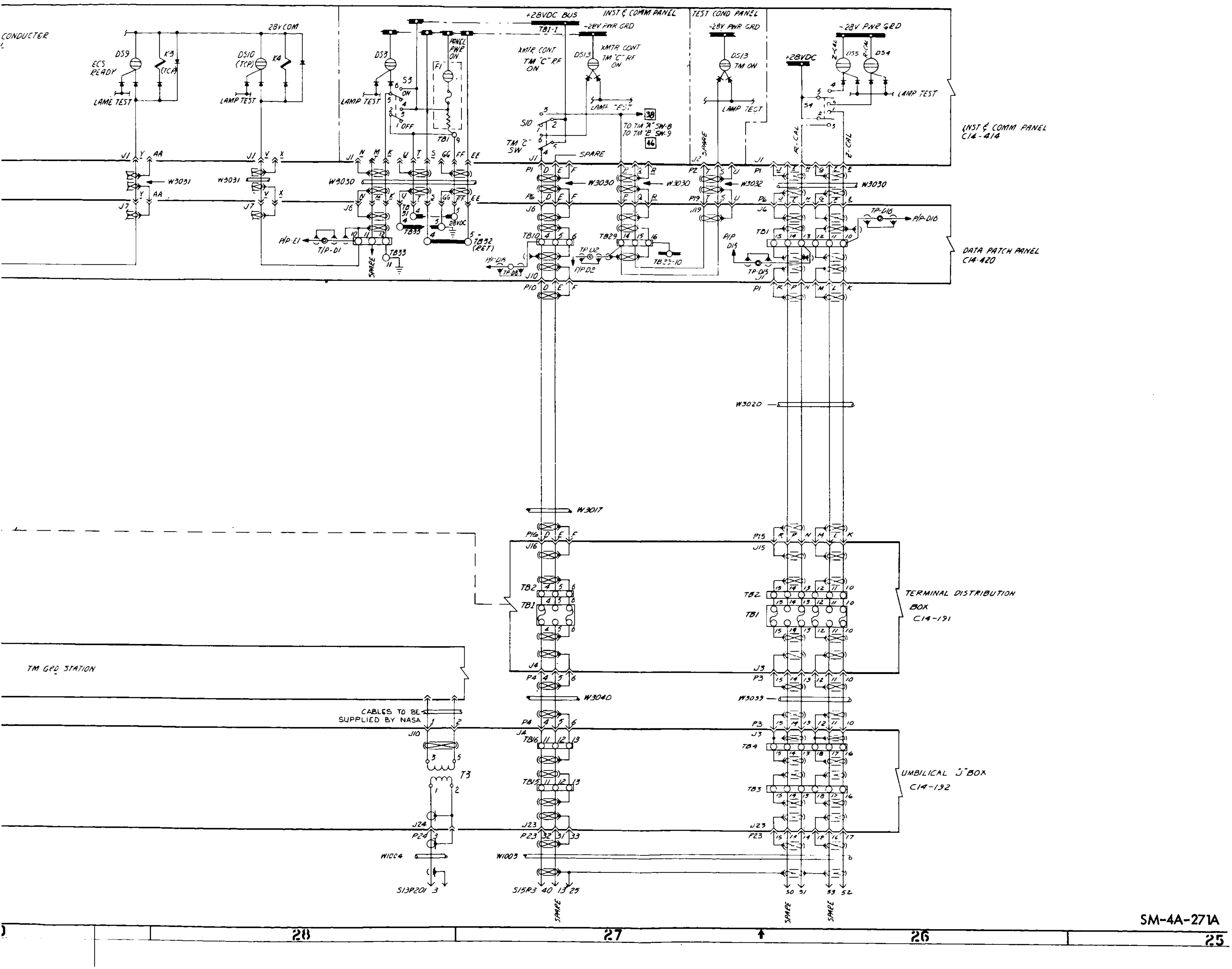
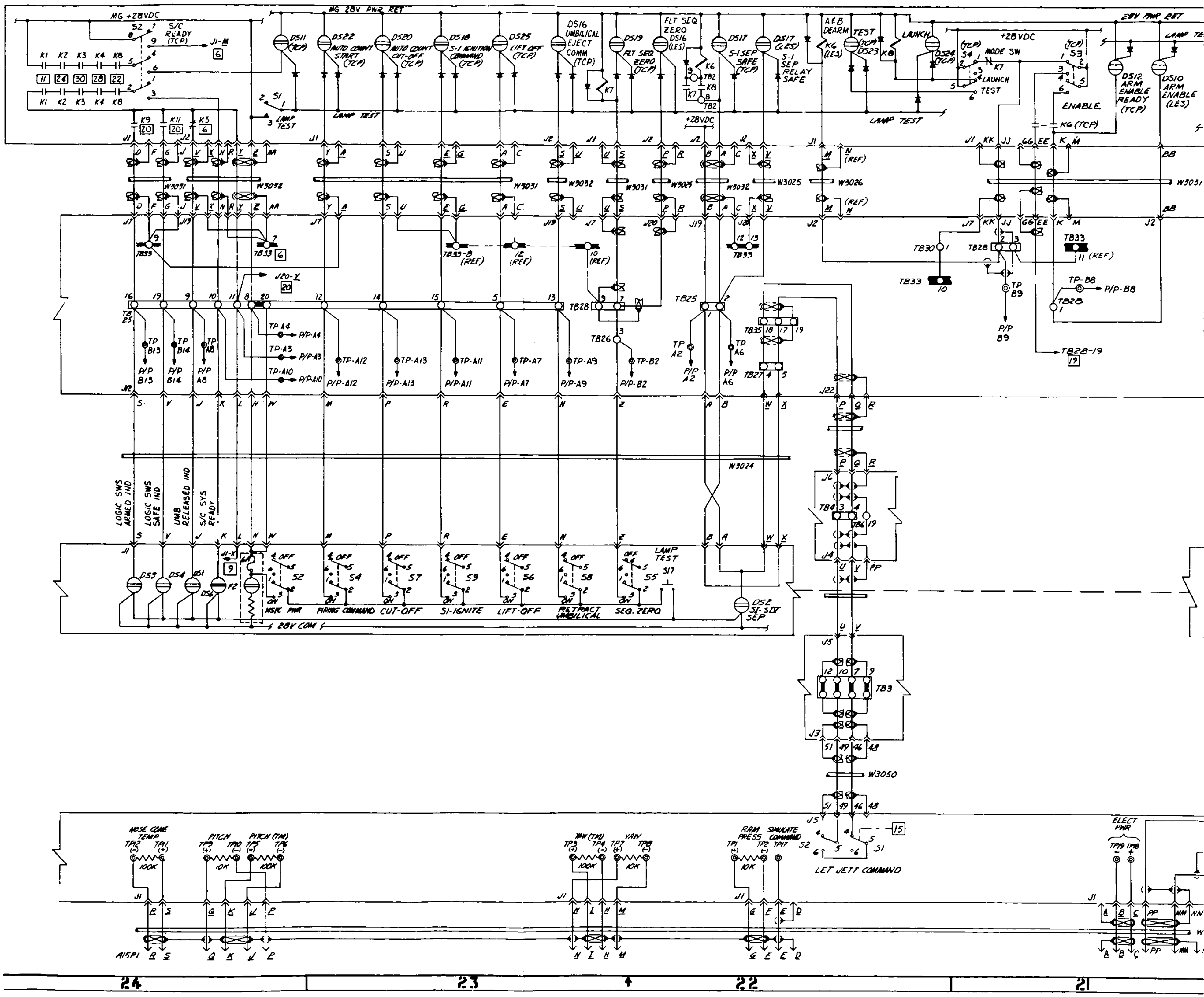
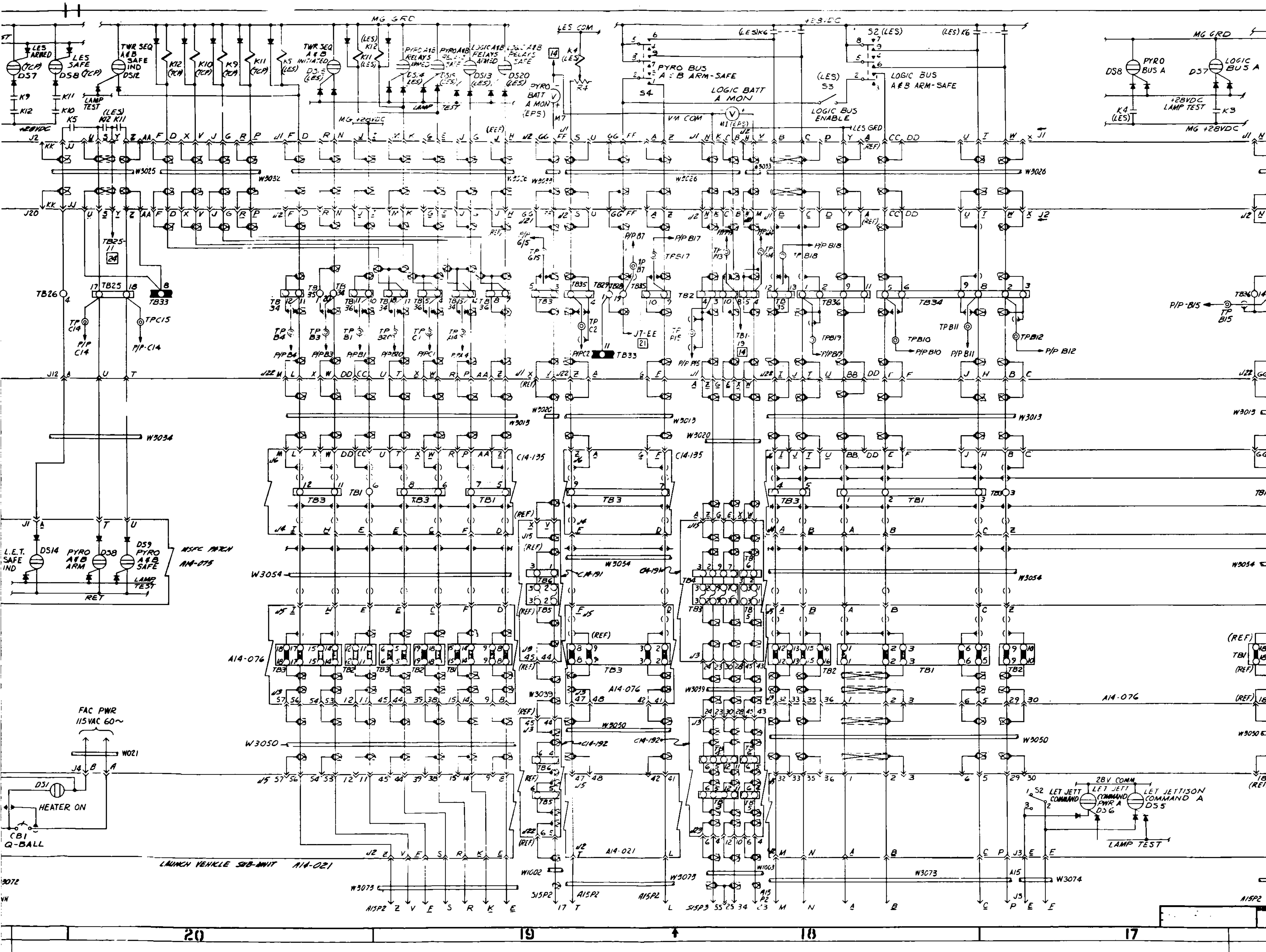


Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004)
(Sheet 4 of 6)


MG +28VDC
MG 28V PWR RET
S/C READY (TCP)
LAMP TEST
DS11 (TCP)
DS22 AUTO COUNT START (TCP)
DS20 AUTO COUNT CUT-OFF (TCP)
DS18 S-1 IGNITION COMMAND (TCP)
DS25 LIFT OFF (TCP)
DS16 UMBILICAL EJECT COMM (TCP)
DS19 FLT SEQ ZERO (TCP)
FLT SEQ ZERO DS16 (LES)
DS17 S-1 SEP SAFE (TCP)
DS17 (LES) S-1 SEP RELAY SAFE
A & B DEARM
TEST
LAUNCH
+28VDC
MODE SW
LAUNCH
TEST
ENABLE
K6 (TCP)
DS12 ARM ENABLE READY (TCP)
DS10 ARM ENABLE (LES)
28V PWR RET
W3091
W3092
W3032
W3025
W3026
W3024
W3050
LOGIC SWS ARMED IND
LOGIC SWS SAFE IND
UMB RELEASED IND
S/C SYS READY
LAMP TEST
MSFC PWR
FIRING COMMAND
CUT-OFF
SI-IGNITE
LIFT-OFF
RETRACT UMBILICAL
SEQ. ZERO
DS2 SI-SII SEP
28V COM
NOSE CONE TEMP
PITCH
PITCH (TM)
YAW (TM)
YAW
RAM PRESS
SIMULATE COMMAND
LET JETT COMMAND
ELECT PWR
A15P1
24
23
22
21


MG GRD
+28 VDC
LES COM
LES ARMED
LES SAFE
TWR SEQ A&B SAFE IND
TWR SEQ A&B INITIATED
PYRO A&B RELAYS ARMED
PYRO A&B RELAYS SAFE
LOGIC A&B RELAYS ARMED
LOGIC A&B RELAYS SAFE
LAMP TEST
PYRO BATT A MON (EPS)
PYRO BUS A & B ARM-SAFE
LOGIC BATT A MON
LOGIC BUS A&B ARM-SAFE
LOGIC BUS ENABLE
VM COM
LES GRD
PYRO BUS A
LOGIC BUS A
+28VDC LAMP TEST
MG +28VDC
W3025
W3032
W3026
W3013
W3034
W3020
W3054
W3039
W3050
W3073
W3074
W021
C14-135
C14-191
C14-192
A14-076
A14-021
L.E.T. SAFE IND
PYRO A&B ARM
PYRO A&B SAFE
MSFC PATCH A14-075
RET
FAC PWR 115VAC 60~
HEATER ON
CB1 Q-BALL
LAUNCH VEHICLE SUB-UNIT A14-021
28V COMM
LET JETT COMMAND PWR A
LET JETTISON COMMAND A
20
19
18
17

2

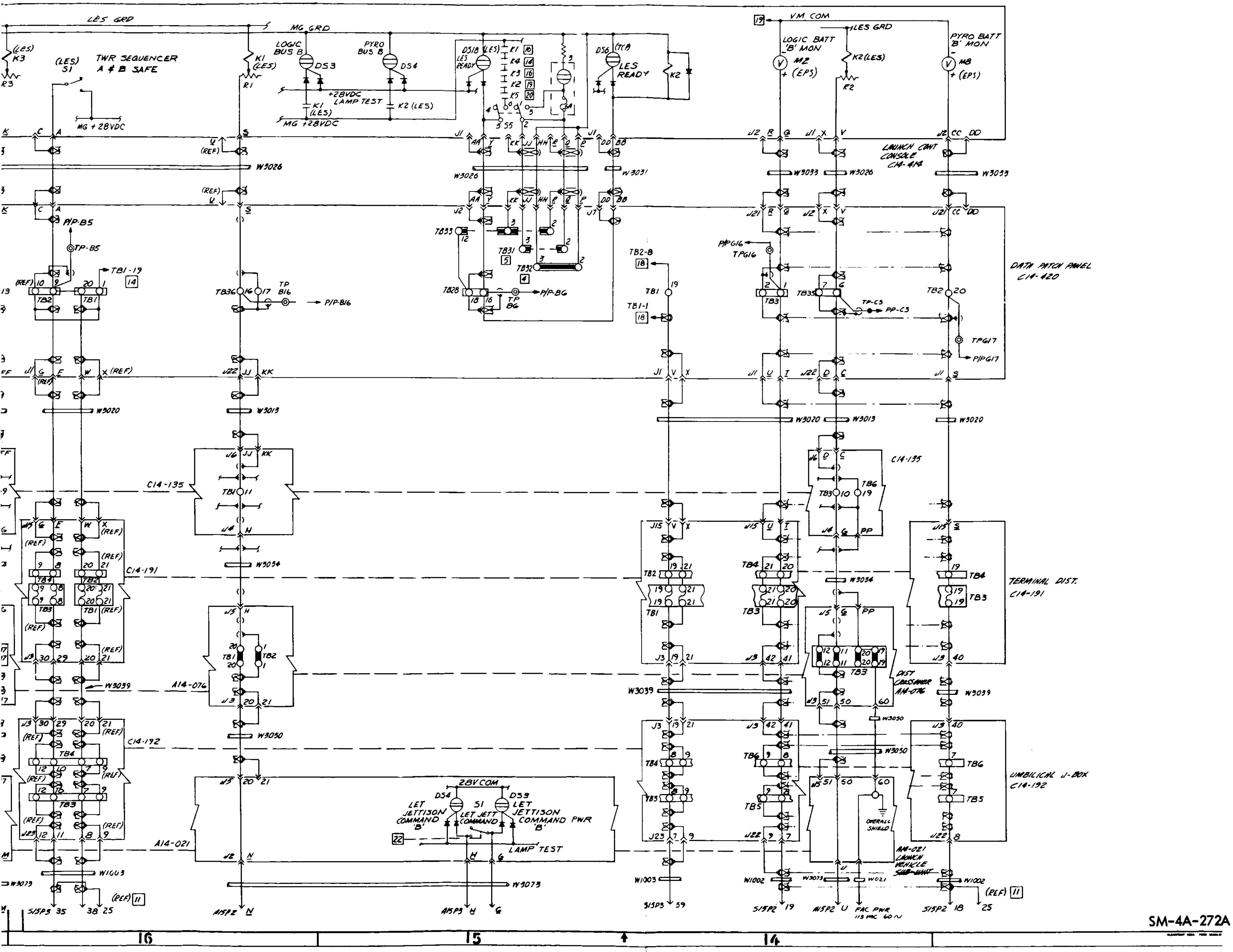
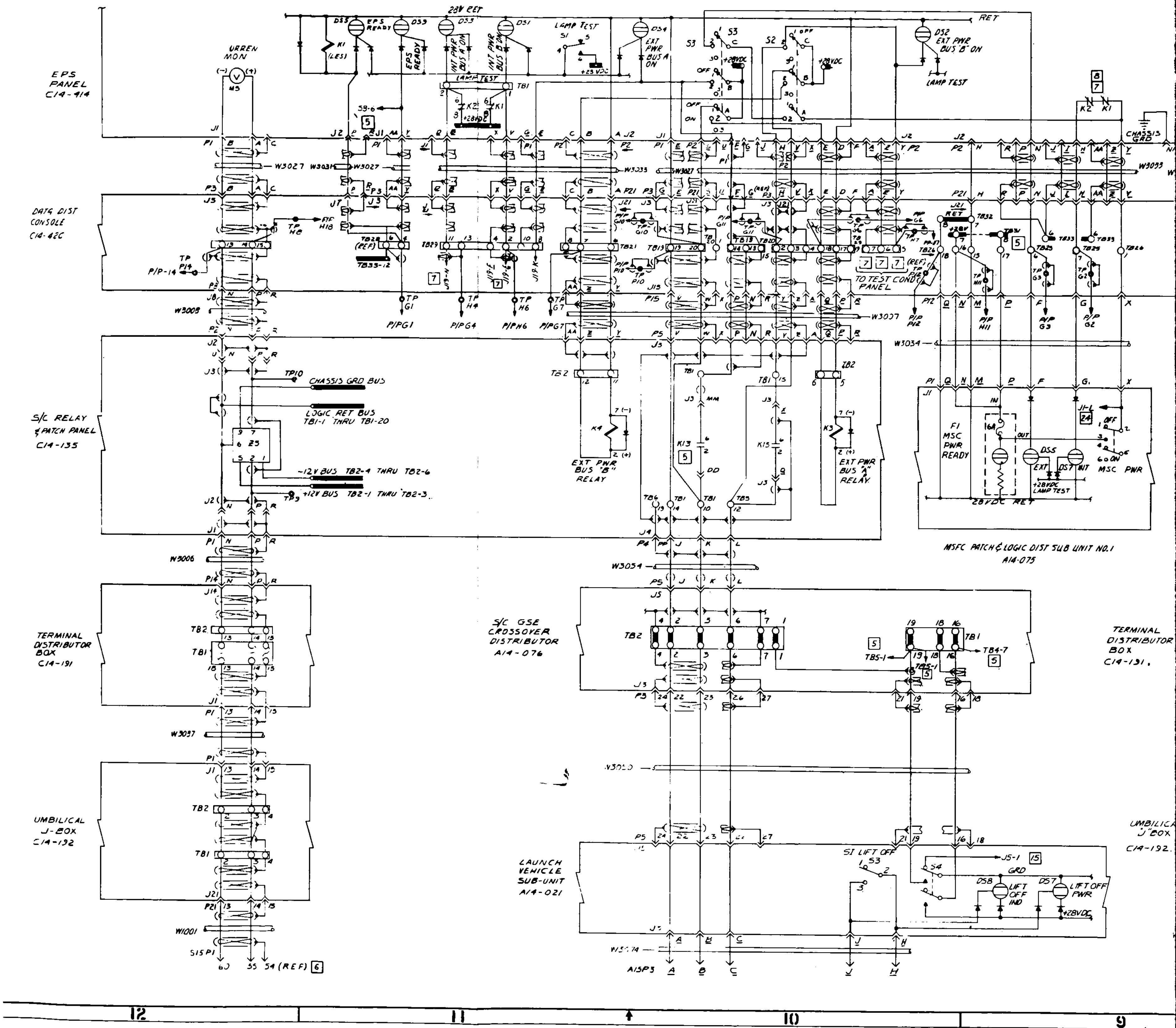
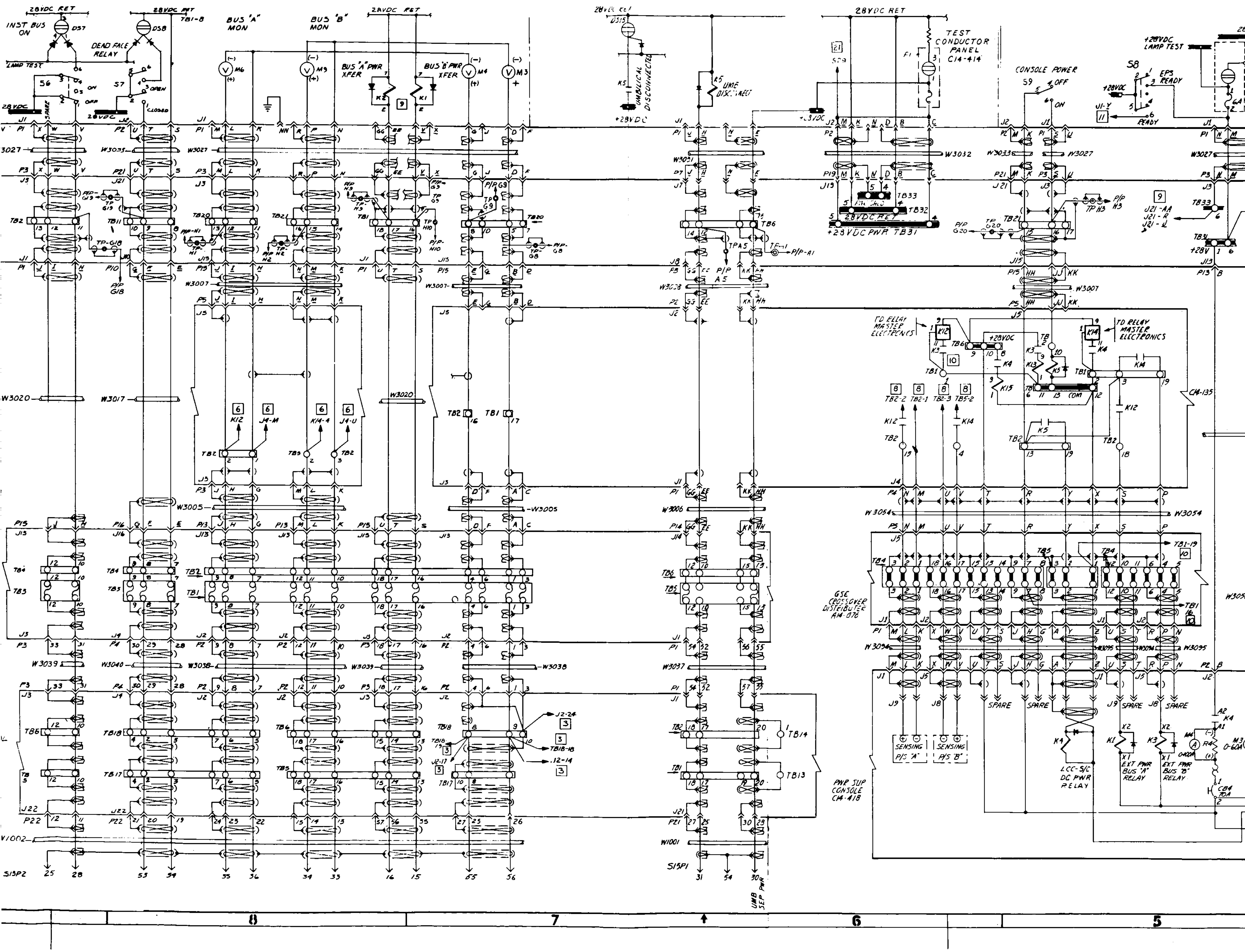



Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004) (Sheet 5 of 6)


EPS PANEL C14-414
DATA DIST CONSOLE C14-42C
S/C RELAY & PATCH PANEL C14-135
TERMINAL DISTRIBUTOR BOX C14-191
UMBILICAL J-BOX C14-132
S/C GSE CROSSOVER DISTRIBUTOR A14-076
LAUNCH VEHICLE SUB-UNIT A14-021
MSFC PATCH & LOGIC DIST SUB UNIT NO.1 A14-075
TERMINAL DISTRIBUTOR BOX C14-131.
UMBILICAL "J" BOX C14-132.
28V RET
LAMP TEST
EXT PWR BUS "B" ON
CHASSIS GRD
CHASSIS GRD BUS
LOGIC RET BUS TB1-1 THRU TB1-20
-12V BUS TB2-4 THRU TB2-6
+12V BUS TB2-1 THRU TB2-3
EXT PWR BUS "B" RELAY
EXT PWR BUS "A" RELAY
TO TEST COND PANEL
F1 MSC PWR READY
MSC PWR
28VDC RET
SI LIFT OFF
LIFT OFF IND
LIFT OFF PWR
12
11
10
9


28VDC RET
INST BUS ON
DEAD FACE RELAY
LAMP TEST
BUS "A" MON
BUS "B" MON
BUS "A" PWR XFER
BUS "B" PWR XFER
UMBILICAL DISCONNECTED
UMB DISCONNECT
+28VDC
TEST CONDUCTOR PANEL C14-414
+28VDC PWR TB31
CONSOLE POWER
OFF
ON
+28VDC LAMP TEST
EPS READY
READY
TD RELAY MASTER ELECTRONICS
GSE CROSSOVER DISTRIBUTER A14-076
PWR SUP CONSOLE C14-418
SENSING P/S "A"
SENSING P/S "B"
SPARE
LCC-S/C DC PWR RELAY
EXT PWR BUS "A" RELAY
EXT PWR BUS "B" RELAY
UMB SEP PWR
8
7
6
5

2

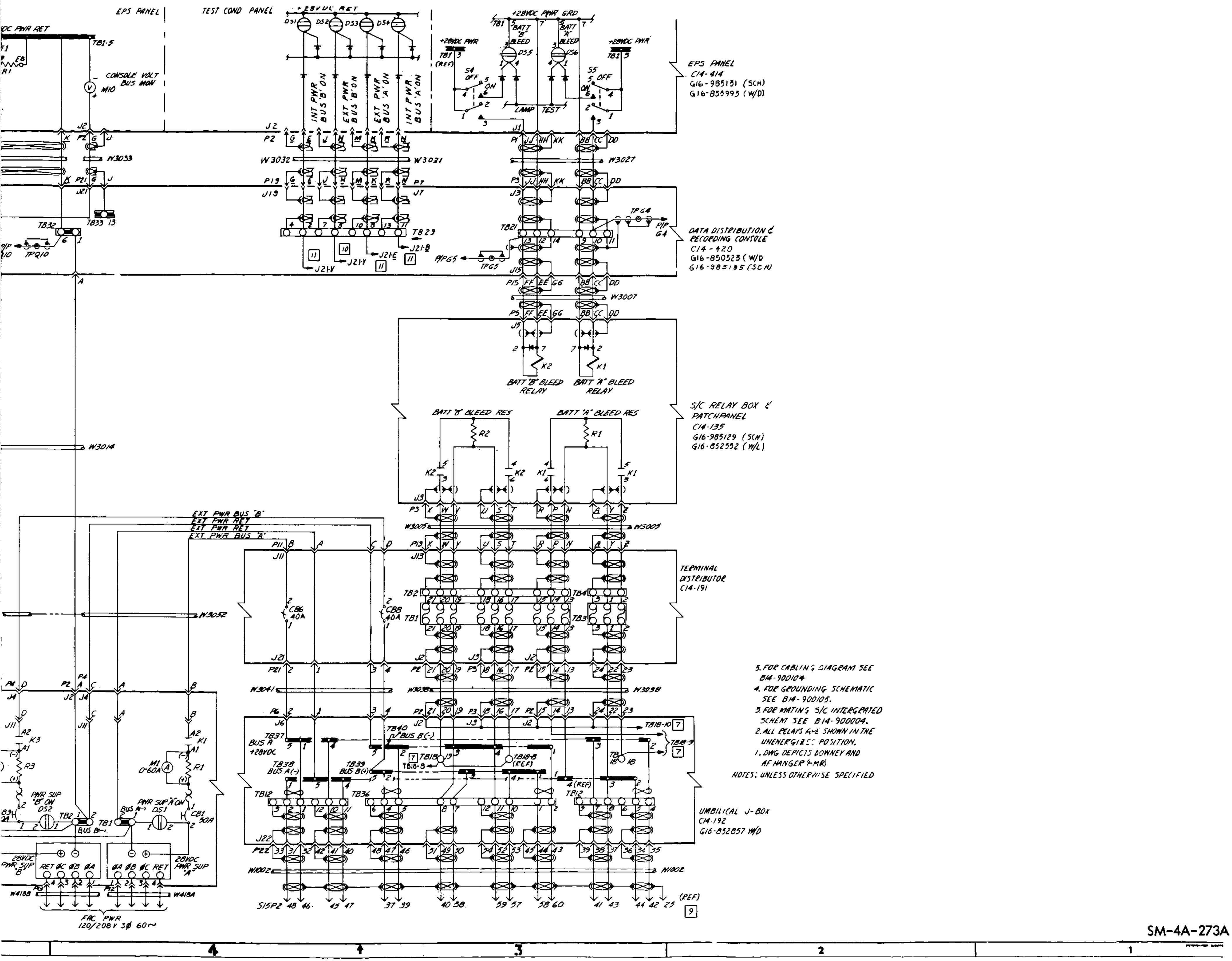



Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004) (Sheet 6 of 6)

3